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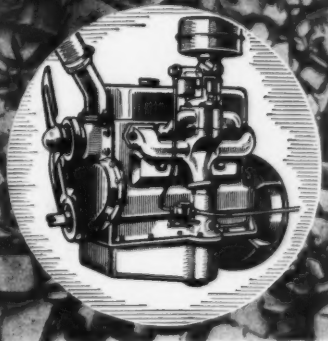

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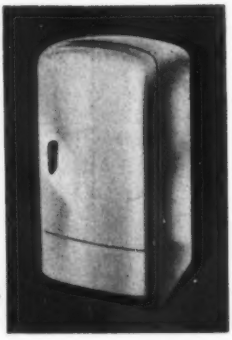

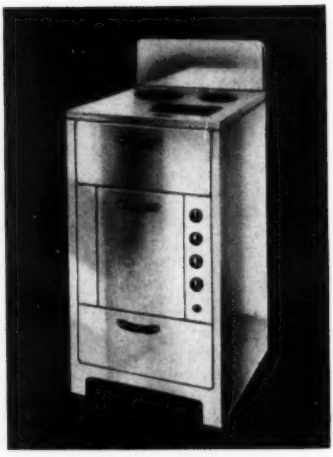

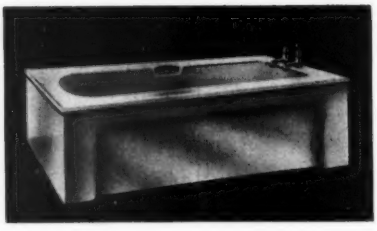

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THIS JOURNAL IS DEVOTED TO THE SCIENCE AND TECHNOLOGY OF PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, ANODIZING, METAL SPRAYING AND ALL METAL FINISHING PROCESSES.

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THREE QUESTIONS FOR 1956

THE general all-round progress in British industry during the past year has been reflected in the continued growth and expansion, both commercial and technical, of all branches of the metal-finishing industry which has accompanied it. Many times in the last twelve months we have had cause to report in our News pages that a company associated with the industry has extended its premises and increased its facilities, and this process at the moment shows every sign of continuing, despite the squeezing of credit and the rapid growth of competition from overseas.

There are therefore many who regard the future prospects of the industry as good and have given active proof of their faith by the further investment of their capital in the industry. On the other hand however, there have been those who have seen fit to sound warnings that the current tide of prosperity can only be maintained if full and proper attention be paid to the need both for skilled workpeople, and for an amount of scientific investigation into the technology of the subject, at least equivalent to that which obtains in those countries which are our commercial rivals.

There are three basic questions which those who hold responsible positions in all branches of the metal-finishing industries (and indeed, in many other industries which do not concern us here) should keep constantly before them and should assure themselves that the answers represent a state of affairs which is at least comparable with that obtaining elsewhere. These questions could be posed as follows:

Are we satisfied that sufficient research and investigation is being undertaken in this country to ensure that we do not fall behind in the race for technical supremacy, and if we are not satisfied that this is the case, are there steps which we can take to improve the situation?

Are we satisfied that in our own particular organization, be it large or small, we are keeping ourselves fully acquainted with all technical advances which affect our industry and are making every possible use of them to improve our efficiency?

Are we satisfied that the supply of properly trained personnel is going to be sufficient to meet the future needs and probable expansion of this industry, and if this is not the case, what means are available of ensuring the supply?

It would indicate a considerable degree of complacency if anyone were to express himself as being completely satisfied on the three issues raised above. We are well aware that in certain quarters anxiety is felt concerning the present position with regard to research and investigational work, the amount of development work being carried out on such research findings as are available, and on the training of workpeople and technologists. We are also aware that certain action is contemplated to improve the position. Where however, we feel that some improvement could be made is in the quickening of the industrial conscience in these matters. It would be a matter of grave concern if the present palmy days of prosperity were to lull the industry into a false sense of security, and blind them to the realities of the situation.

In the twelve months that have passed since the re-emergence of this Journal in its present form, we have become increasingly aware of our own responsibilities in this connexion. We have sought to draw attention to the research facilities which already exist, and in this way to make some indication of how they can be assisted and extended. We have described new finishing techniques in the hope that application for them may be found somewhere within the industry. We have published descriptions of finishing installations which have seemed to us to be outstanding achievements of their kind so that others may be inspired to emulate the productivity which they typify.

We hope that in continuing and extending this policy we shall be in a position to be of even greater service to the industry during 1956.

Talking Points by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

KEEPING IT CLEAN

THERE is a good deal of published work on the subject of rinsing which is of a theoretical nature, and it is not always easy to see how the data can be applied in practice in particular cases. Certain principles are, however, reasonably well established. Thus, it is, or should be, well known that rinse tanks should be as small as is practicable, and that a series of tanks with a relatively limited rate of change of water is more economical than a single tank with a high water input.

Automatic control of rinse tanks is becoming more and more common in the United States; the method employed is to utilize a *p*H meter to turn on the water valve when a pre-determined degree of contamination is reached. Whether such an installation is worthwhile in any particular case depends on whether the economies which can be affected will offset the not insubstantial cost of the control unit.

These thoughts are prompted by the fact that the economic use of water in plating plants is becoming more important than ever now that some local authorities are asking for payment on a gallonage basis for effluent discharged to the sewers even if this has been effectively purified. Paying for water twice over, which is what this amounts to, makes a careful study of where economies can be affected well worth while.

MONKEY BUSINESS

THE following advertisement appeared in *The Times* one day last month:

> "Writer doing research into the earning capacity of monkeys would be glad to know the whereabouts of monkeys who perform tasks normally carried out by humans. Box—".

This raises the most interesting possibilities so far as our industry is concerned, where the employment of trained monkeys might be the answer to a good many problems. For instance, the design of some automatic plating plants is such that the operator needs to hang by one arm from an overhead gantry in order to feed work to them. Certainly the retrieving of work which has fallen from the plants and the servicing problems which they raise is physically very suitable for monkeys. Other advantages of employing monkeys which spring to mind are that, not having to shave in the mornings they will be better timekeepers, while their well-known ability to amuse themselves means that they will not require television sets, cinemas and the other expensive accoutrements of civilisation, so that their employment would be most economic. On the other hand, there would probably be trouble with the Trade Unions.

The employment of monkeys in executive positions must also not be ruled out. Like most jungle denizens they seem to stand up to nervous strain better than humans. Constantly subject to the danger of sudden death by traps, guns, predatory beasts, and natural hazards which make the life of an industrial tycoon a picnic by comparison, they do not seem to have breakdowns or have to take sedative pills to prevent themselves going to pieces. All in all the objects of the research seem to be worthy of support in a good many quarters.

FUN AND GAMES

WHERE is the business of entertaining as applied to commercial relations going to end? It is old established practice for customers to be taken out to lunch by suppliers, or even *vice-versa* when materials become short. But the latest development is that a well-known firm of advertising specialists is arranging for its secretarial staff to entertain the secretaries of the executives and directors of the companies with which they have dealings because so many matters are discussed and arranged at this level, while the individuals concerned remain voices on the telephone to each other for the most part.

Commendable as the idea may appear in principle, one can foresee extensions of the scheme which may pay dividends. A firm of outplaters, for instance, might arrange for the platers to entertain the inspectors of its main customers; if they got to know each other really well over a glass of beer and a game of darts, the number of components returned for re-plating would probably be reduced much more than if the managing director of the one firm entertained the managing director of the other at the Ritz. By the same token, platers could entertain polishers, tool setters could fête press operators, paint mixers could lunch with sprayers, and "Platelayer" could have a night out with the linotype operators. A good time would be had by all, except perhaps the Chancellor of the Exchequer.

A Description of the

AUTOMATIC NICKEL-CHROMIUM PLATING LINE

in operation at the Luton Works of

VAUXHALL MOTORS LTD.

THE steady increase in the output of motor-cars during recent years in this country, and the incorporation in their design of substantial areas of nickel-chromium plate, has made it necessary for electroplating facilities at the works of car manufacturers to be considerably extended, and whenever possible, rendered automatic.

It is symptomatic of this trend that an automatic nickel-chrome plating plant, the first of its type to be installed in any motor-car factory in Europe is in operation at the Luton works of Vauxhall Motors Ltd. for the plating of sheet-metal pressings. This plant was installed a little over eighteen months ago and has been operating continuously since that time. Not unnaturally certain problems were encountered in the initial stages of its operation, but these have now been largely resolved in the light of experience and experiment, and at the present time the plant with its associated manual and automatic polishing lines, and manually operated plating installations, is producing a very high standard of finish indeed.

This plant, whose overall dimensions are 180 ft. long × 30 ft. wide, comprises 22 pairs of process tanks, arranged in two parallel rows, each tank being 6 ft. wide and 7 ft. deep.

The principal feature of the plant is the process conveyor system, which carries the suspender loads of components automatically through the complete sequence of 22 operations. An auxiliary transport conveyor system feeds the main plant with loaded suspenders and also delivers finished plated parts to the inspection bay and thence to the assembly area.

A total of 34 sq. ft. of chromium-plated material can be produced every 3½ min., and 72 suspender loads of components are delivered per hour.

The bulk of the components plated in this plant are steel pressings, and it is to the processing of these that this description applies. Every effort is made at all stages of manufacture to eliminate the need for polishing of the steel surface as this not only substantially increases the cost of plating the components, but also tends to reduce the durability of the plated finish.

With this aim in view emphasis is placed on obtaining sheet metal with a suitable initial surface finish, although under existing conditions of shortage, it is becoming increasingly difficult to ensure consistency in this respect. Operations in the press-shop are so conducted that the minimum of damage is done to the sheet surface, although due to the shape of certain components draw marks are unavoidable in one or two cases, so that a single steel polishing operation is standard. Apart from these instances steel polishing is only carried out at inspection request arising from bad surface, die marking or damage, etc.

Prior to processing in the automatic plant all components are copper plated. This operation is carried out manually and the sequence of operations is as shown in Table I. The company proposes to install automatic equipment for copper plating of the same working capacity as the present automatic nickel-chromium plant within the next eighteen months, and when this is operating the number of operations in the processing sequence will, of necessity, be considerably increased.

The solution used contains addition agents in order to give semi-bright deposits with some levelling action. It is possible to achieve full brightness with maximum levelling effect, but this

TABLE I.
Copper Plating Sequence.

Process	Time
1. Alkali soak clean	3 minutes
2. Cold electric cleaner	3 minutes
3. Swill	
4. Anodic sulphuric-acid etch	1 minute
5. Swill	
6. Sodium-cyanide dip and storage	
7. Cyanide-copper strike	10 minutes
8. Reclaim rinse	
9. Swill	
10. Sulphuric-acid dip	
11. Acid copper plate	60 minutes
12. Reclaim rinse	
13. Swill	
14. Hot swill and dry off.	

necessitates extreme care in the control of the solution. On some components it would be possible to obtain an adequate surface finish without polishing at any stage, but it is considered essential to polish the copper in order to improve the service performance of the final deposit and to mask any irregularities in the surface of the steel. The thickness of the copper deposited prior to polishing is a minimum of 0.001 in.

The major part of the plated surface is polished on "in line" automatic machines employing conveyors and composition applicators designed and developed by the company and using Canning balanced type heads. Initial polishing is with Tripoli composition followed by "colouring off" with lime. The specially designed applicators

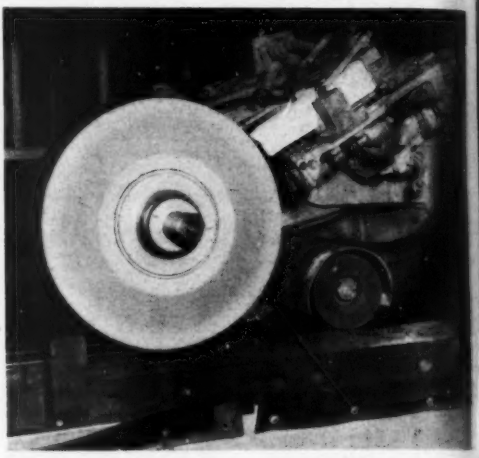


Fig. 2.—Close-up view of one of the five copper-polishing mop heads with automatic lustre-polish applicator.

accommodate bars of composition 26 × 3 × 2 in. so that two bars give a maximum working width of 6 in. The wheels are 16 in. diameter bias-cut ventilated buffs running at 2000 r.p.m. These are usually discarded when they are worn down to 10 to 12 in. diameter and can then be used on hand buffing spindles at 2920 r.p.m. In most cases it is not possible to cover the entire surface of the component on the automatic lines, so subsequent touching up on the hand machines is necessary. In addition, those components which do not lend themselves to processing on the

Fig. 1.—General view of the automatic in-line polisher from the off-loading end. This line polishing set-up can handle 550 to 600 Vauxhall bonnet flutes per day. The jigs carry two flutes at a time and the mops are contoured to match the shape of the flutes. After passing the polishing heads the jig is tipped automatically on to a gravity run-way. The jig is given an initial push by a driven portion of the roller conveyor.

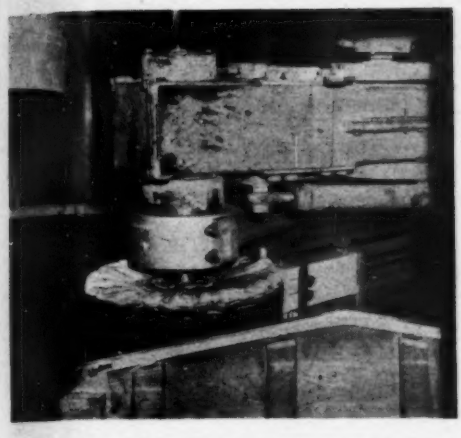


Fig. 3.—Close-up view of horizontally mounted polishing head on second in-line machine. Applicators on this machine are hydro-pneumatically operated.

automatic machines are polished by hand. Components which on subsequent inspection reveal polishing through to the steel base on significant surfaces are returned for re-plating with copper.

After they have been polished the components are loaded into trays and placed on pallets ready for transfer by "fork lift" trucks to the loading bay of the automatic plant, as shown in Fig. 5 where they are transferred to plating suspenders, coated with an insulating plastic.

The suspenders are then taken to the loading end of the automatic plant by the auxiliary conveyor and are positioned in four pneumatically operated locking gates, in readiness for their final transfer to the " flight bars " of the plating plant (Fig. 6.).

This transfer is effected by means of two wheeled carriages fitted with pneumatic hoists, each carriage being capable of handling two loaded suspenders for feeding each line of tanks. (Fig. 7).

Fundamentally the plant consists of two identical lines of processing tanks, each with two lanes of work with a central chain conveyor to move the work through the tanks. The conveyor is driven by an electric motor, through a gear reduction box (ratio 3,000 : 1), with a final chain drive to the conveyor chain sprocket shaft, through a shear pin coupling. Speed of chain is 9 in. per min., or 4 rev. per hour of sprockets.

Fastened to the chain are attachment plates which push the 121 flight bars along the upper and lower tracks. On the lower track or cathode-current-carrying Delta track, the flight bars run on bronze shoes, while on its return on the upper track in an upside-down position, a cast-iron shoe is provided. The upper track is provided with rollers, in order to reduce friction. Good electrical contact between the suspenders and the flight bars is ensured by a male and female cone fitting.

Sections of the Delta track are lifted by carriages on lifting towers (*see* Fig. 8) to effect transfer of work from tank to tank. With the track in the " up " position, the flight bars are pushed along

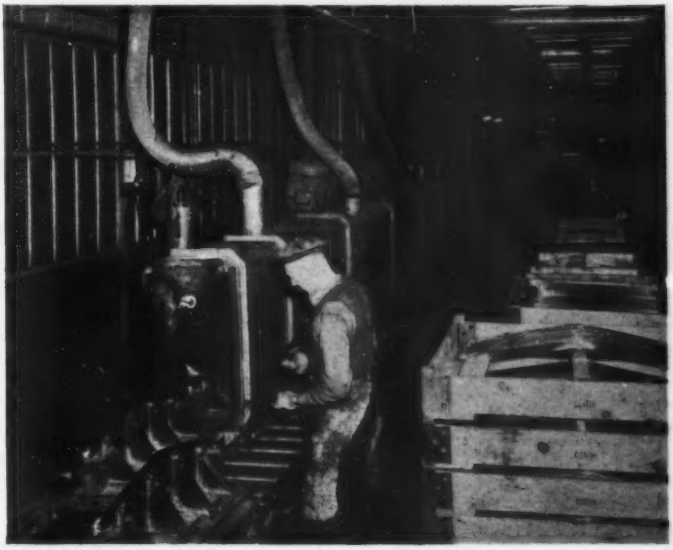


Fig. 4.—General view of second in-line polisher. This machine copper polishes two components, viz.:
Upper grille (two at a time)
Lower grille (one at a time).
The lower grille is shown being polished. Output is 400-450 *per day of both grilles.*
There are two vertical, contoured mops and two horizontal mops. The latter are cut out of sequence for the upper grille.
The return conveyor is not inclined but has short sections of chain-driven rollers.

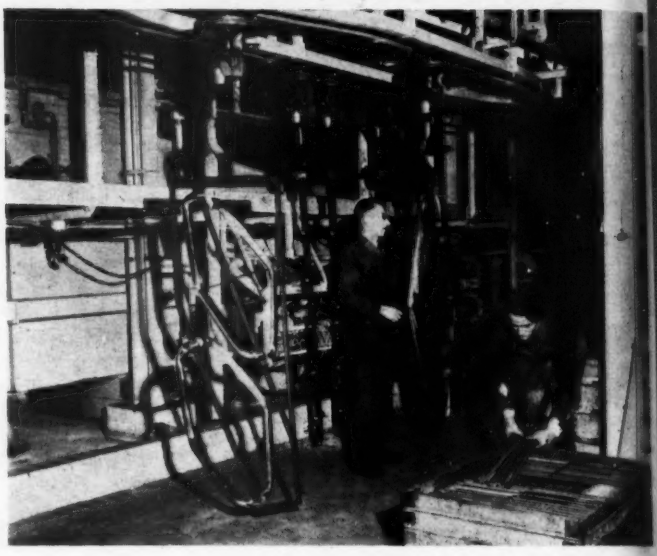


Fig. 5.—Components being loaded on to the plating racks on the auxiliary conveyor for transfer to the loading end of the automatic lines.

by a transfer bar, operated by means of a motor-driven rack and pinion, (Fig. 9) to a position above the next tank. The tower carriage then falls, complete with section of Delta track, flight bars and plating suspenders. The flight bars fall into their relative attachment plates (also shown in Fig. 8), and are then once again able to carry the plating suspenders through the solution at conveyor speed.

The limit switches controlling these movements are operated by rollers on the main conveyor chain, which means that the time spent in the

TABLE II. *Automatic Plating Sequence.*

Process	Time Mins.	Solution	Temp. °F.	Agitation	Remarks
1. Power agitated clean	2½	Alkali	140	Forced Circulation	
2. Power spray	1	Weak alkali	140	—	
3. Soak cleaner	2½	Alkali	150	Air	
4. Cathodic cleaner	2½	Cyanide	Room	Air	Final 3 secs. reverse current
5. Swill	1	Water	Room	Air	
6. Swill	1	Water	Room	Air	
7. Acid dip	1	5% H_2SO_4	Room	Air	
8. Swill	1	Water	Room	Air	
9. Copper	10	Cuprobrite	160	Air	Min.deposit 0.0002in.
10. Swill	1	Water	Room	Air	
11. Swill	1	Water	Room	Air	
12. Acid dip	1	5% H_2SO_4	Room	Air	
13. Swill	1	2½% H_2SO_4	Room	Air	
14. Bright nickel	60	Gleamax	130	Mechanized	Min.deposit 0.001in.
15. Reclaim rinse	1	Water	Room	Air	
16. Swill	1	Water	Room	Air	
17. Swill	1	Soft water	Room	Air	
18. Chrome	6½	Chrome acid	130	Air	Min.deposit 0.00001 in.
19. Reclaim rinse	1	Water	140	Air	
20. Neutralizer	1	Soda ash and sodium hydrosulphite	140	Air	
21. Swill	1	Water	Room	Air	
22. Hot rinse	1	Soft water	180	Air	

Fig. 6.—Loaded racks at the loading end of the automatic lines awaiting transfer to the plating conveyor.

various tanks is dependent upon the speed of the conveyor.

To avoid damage in the event of carriage lifting failure, the main motor is cut out by the action of one of the flight bars tripping an " over-run " switch.

A specially heat-treated shear pin safeguards the drive unit against excessive loads, and the shear pin coupling is fitted with an additional electrical safety device, which stops the complete plant directly the shear pin starts to fatigue.

Nickel-chromium Plating

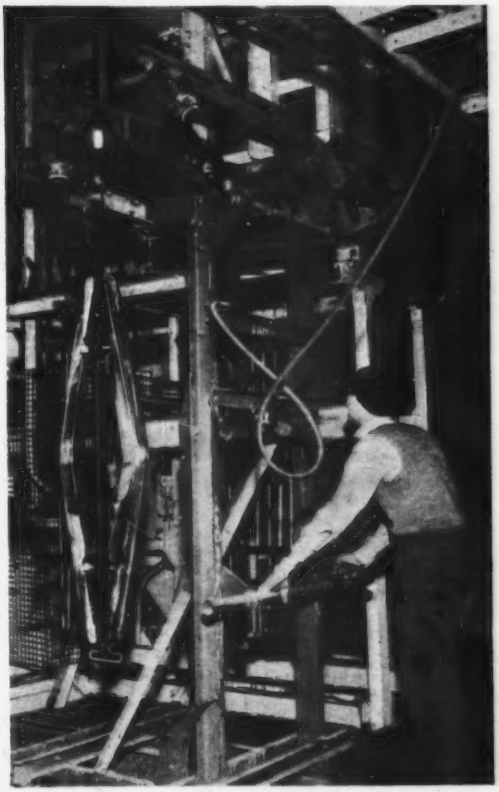
The sequence of operations in the automatic nickel-chromium line is set out in Table II. The initial cyanide copper coating, deposited in a "Cuprobrite" solution, is employed to improve adhesion, to replace part of the copper removed during polishing and to give a final cleaning action prior to nickel deposition. The current density employed is of the order of 15-20 amp. per sq. ft. giving an average thickness of deposit of 0.0004 in. which may be as low as 0.0002 in. on recessed or awkwardly shaped components.

Nickel is deposited bright in a "Gleamax" solution at a current density as high as possible without causing burning on the more difficult shaped components. An average value is of the order of 30 amp. per sq. ft. although this figure is not very significant in view of the great variety in shape and size of the components plated. A minimum thickness of 0.00075 in. is achieved but the average thickness is necessarily greater than this.

Chromium plating is carried out in a typical chromic/sulphuric acid solution operated at 130°F and approximately 300 amp. per sq. ft. The deposit obtained under these conditions contributes substantially to the serviceability of the finished component.

To ensure that the quality of the product is maintained at the specified high standard all solutions are checked for individual constituents weekly and in some cases, daily. In addition regular controlled tests are carried out with the Hull cell. To ensure that the minimum thicknesses

Fig. 7.—Loaded rack being transferred by air-hoist to the plating conveyor. The socket connexions on the flight bars can be seen into which the cone end of the rack is fitted.



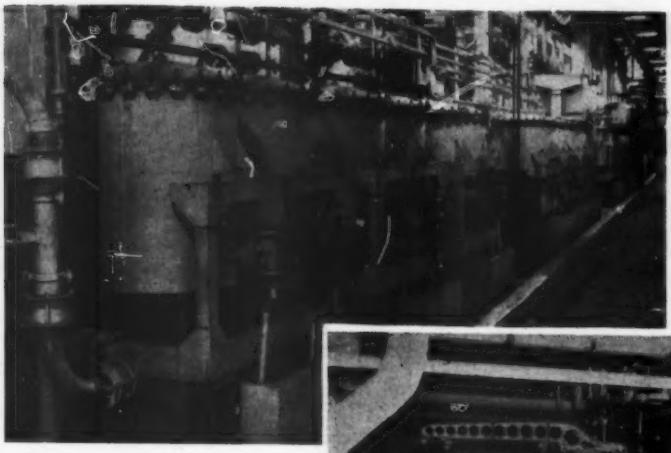


Fig. 8 (left).—*View along the line of filter units and pumps. The cyanide copper and bright nickel solutions are continuously filtered through enclosed plate-type filters.*

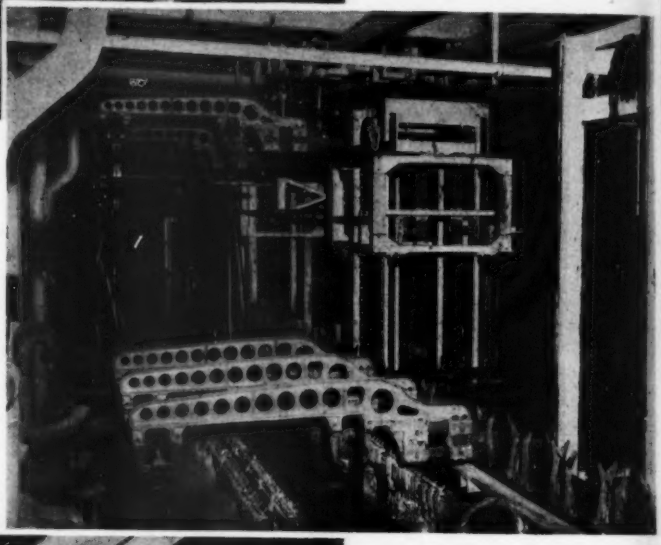


Fig. 9 (*right*).—*Work being processed through one side of the automatic line. In the foreground plating is in progress in one of the tanks and in the background the flight bars have been raised at a transfer station.*

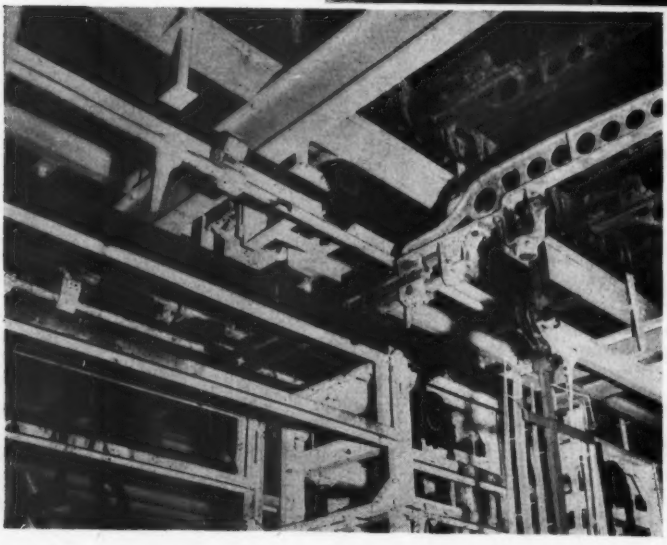


Fig. 10 (*left*).—*Close-up view of a flight bar in the raised transfer position showing the rack and pinion transfer drive mechanism.*

specified are maintained, plated samples are checked at regular intervals for thickness of every coating deposited. Periodic checks on ductility of the deposit are also made on special strips plated for the purpose.

Tests for resistance to the standard salt spray test are also carried out, although no very great reliance is placed on the results of these. The greatest emphasis is placed on control of thickness of deposit and precision in plating conditions at every stage in the process. This ensures consistent deposits of the required physical and chemical properties which perform adequately under the varying service conditions which they are called upon to endure in different climatic conditions all over the world.

After the processing is completed, the plated components, still on their suspenders, are transferred to the auxiliary transport conveyor, using similar equipment to that described for loading the plant, where the components are finally removed, passed to the Inspection Dept., and placed in special containers to protect them from damage, before going to final assembly.

Plant Details

Some details of the actual construction and operation of the plant are as follows:

(1) *TANKS*

Cleaner Tanks and reclaim rinse after chrome are manufactured from mild steel and are unlined.

All Swill Tanks, acid dips and main process tanks, except chrome, are mild steel, covered with $\frac{1}{8}$-in. semi-hard rubber and fitted with air agitation.

Chrome Tanks are mild steel lined with antimonial lead and fitted with a screen of P.V.C. covering the lead.

(2) *HEATING OF SOLUTIONS*

The copper and nickel tanks are heated by external rubber-lined heat exchangers, with pump circulation. The chrome tank is heated by an outer water jacket containing closed heating coils, operating off H.P.H.W.

All remaining heated tanks are fitted with closed heating coils operating off H.P.H.W. and immersed in solution.

(3) *FILTRATION*

The copper and nickel solutions are filtered continuously by means of enclosed plate-type filters. Each copper tank containing 2,700 gal. is filtered at the rate of 2,000 gal. per hr. and each nickel tank containing 12,000 gal. at the rate of 6,000 gal. per hr. (Fig. 8).

Copper and nickel solutions can be pumped up to overhead storage tanks *via* the filters. This

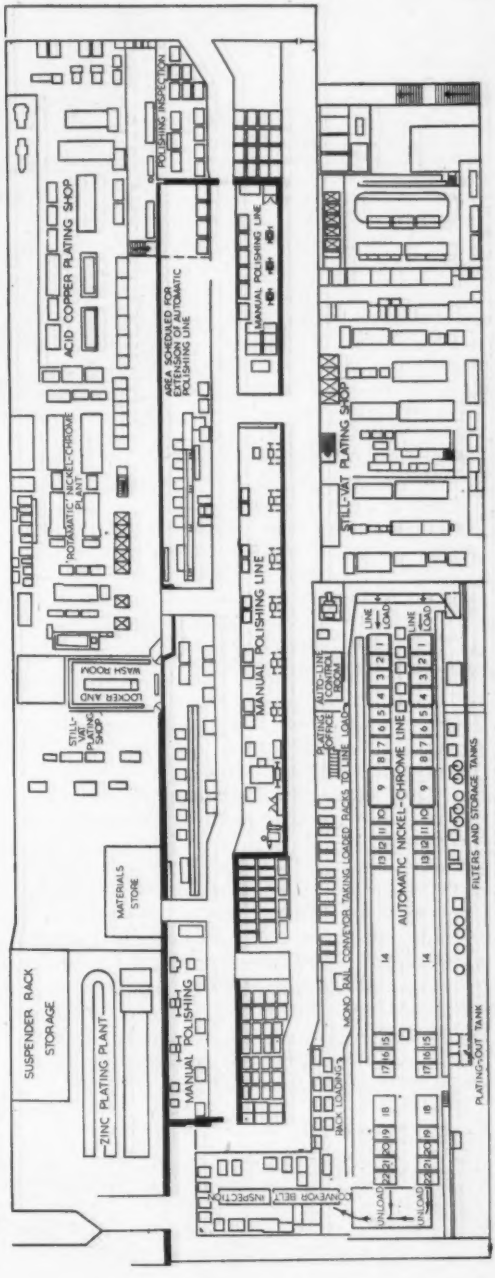


Fig. 11 (right).—Diagrammatic representation of the layout of the plating area showing the disposition of the automatic plating line.

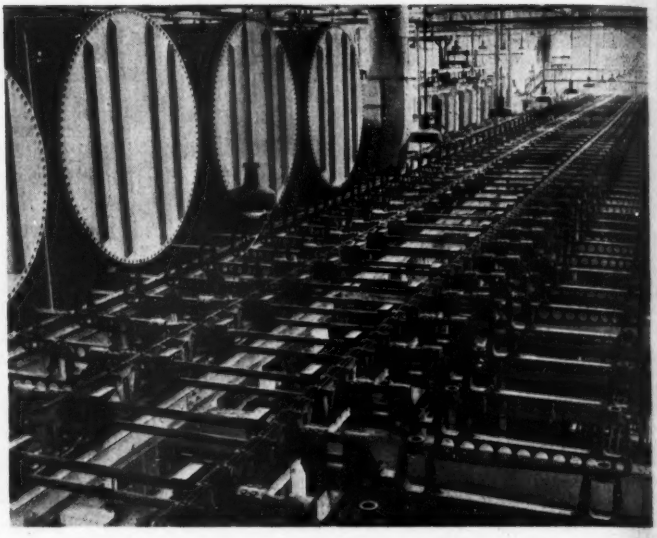


Fig. 12.—General view over the top of the automatic lines, showing the flight bars returning in the inverted position. The solution storage tanks are on the left with part of the rectifier installation visible beyond them.

operation is carried out on a weekly basis to enable the cleaning out of tanks and checking of anodes. (Fig. 7.)

Included in the nickel filtration system is a means of continuously circulating solution through low current density "plating-out" tanks, for removal of metal contaminants.

The chrome solution is not filtered, but can be pumped to overhead storage for tank cleaning and examination of anodes.

(4) *D.C. CURRENT*

Low-voltage direct current for the electrolytic processes, is supplied through the use of oil-immersed metal-plate-type rectifiers and transformer units, positioned on a platform above the plant.

On the copper, nickel and chrome plating processes, motorized regulating transformers give infinitely variable voltage control.

A fairly elaborate control system is operated from a central control room to give the necessary current control on all electrolytic processes on the four lanes of work.

The total amount of current available for the plating and electrolytic cleaning processes amounts to approx. 64,000 amp.

(5) *AGITATION*

On the nickel tanks solution agitation is carried out by means of impellors fitted in special rubber lined housings.

Agitation on all other tanks is by air, provided by rotary air pumps.

Trouble Shooting

In the early days of operating the plant some trouble was encountered associated with drying off and draining effects during the transfer periods. These gave rise to dull patches, stains, and in some cases, poor adhesion. With the understanding of the causes these troubles have now been eliminated, but this has involved very precise control of the operating details, timing and chemical conditions of the plant.

The most persistent trouble encountered has arisen from the carry over of chromic acid by the plating racks in small imperfections in the insulation coating. As might be expected the entrapment of chromic acid gives rise to contamination of the cleaners and of the cyanide copper solution. Careful attention to the cleaning processes and the incorporation of sodium hydrosulphite in the neutralizer tank has helped to minimize this trouble.

Apart from chromic acid there has been virtually no trouble arising from contamination or the presence of impurities in the plating solutions. This has been achieved largely by the use of continuous purification, including filtration through carbon in enclosed plate-type filters, and the selective plating-out of contaminating metals in a special low-current-density unit through which the nickel solution is circulated.

The precise operation of the plant is complicated by the wide variety in size and shape of component undergoing processing, and as production requirements frequently do not permit of batching of components of equal size, it often happens that

(*Continued in page 22*)

MODERN PAINTING AND STOVING TECHNIQUES

(with particular reference to FLOW COATING)

By J. J. STORDY,* B.Sc., and W. G. J. APPLETON,* A.M.I.Mech.E., M.Inst.F.

Abstract of a Paper presented to a joint meeting of the Organic Finishing Group of the Institute of Metal Finishing and the Midland Branch of the Sheet and Strip Metal Users' Technical Association in Birmingham on November 16, 1955.

IN order to place the flow system of paint application in its true context, it is necessary first to consider the established paint practices in current use at the present time. The accepted paint application methods have therefore been sub-divided into dipping, spraying—covering both hand application and automatic application —and finally flow coating. Further, since the majority of modern finishing materials require heat treatment or stoving after paint application, stoving methods and practice with a brief reference to conveyor systems which can be employed for the various paint application methods, are also discussed.

While in certain industries, particularly the Public Service industry, brush painting is quite widely employed it is not in a paper of this kind necessary to deal in any way with this method of application.

Dip Painting

The great advantage of the dip-coating system is that it ensures complete coverage, particularly of intricately shaped articles, its main disadvantage being the thickness of the applied coating which can, to an extent, be controlled by careful maintenance of paint viscosity, and the tendency, particularly with thick coatings, for runs to develop after withdrawal from the paint dip tank.

For the best results with dip coating it is necessary to have slow immersion and withdrawal rates. Further, great care should be paid, particularly with automatic plants, to jig the parts to ensure adequate drainage and, second, to avoid air traps when the work is immersed, since such air traps will, without doubt, leave a bare patch on the finished surfaces.

For tanks of small size it is not essential to have any means of agitation, but where the tank sizes are in excess of 250-gallons capacity then paint agitation is a necessity in order to ensure that the paint is kept in condition. One method which is employed, particularly on larger tanks, is to arrange for a paddle, immersed in the paint tank and driven through a crank, to give continuous agitation. A more usual method is to use a circulating pump drawing from a fairly high level in the dip tank and delivering to a storage tank, the paint then returning by gravity at low level in the dip tank from the storage tank.

The storage tank, which invariably is used with the larger dip plants, is necessary as a reservoir for the contents of the paint tank when it is required to empty this for cleaning out and maintenance purposes and to contain the paint during shut-down periods to avoid solvent loss which, on tanks with a large surface area, can be very high.

A further point in connexion with dipping plants is that paint viscosities should, as far as practicable, be kept as nearly constant as possible either by control of shop temperature or by installing some form of heating in the paint tank or in the paint delivery branch. Particularly in the United States, heaters on the pump delivery side are very commonly employed, using electricity, steam or hot water as the heat source, such heating systems being provided with thermostatic control. Jacketted tanks circulating warm oil or water have some advantages over immersion-type heaters where there is a tendency for the paint adjacent to the heat source to spoil due to the temperature of the heat source.

The drain length to be allowed after a dipping system should not be less, generally speaking, than fifteen minutes and in some cases may need to be as long as thirty minutes—this point, of course, being dependent on the viscosity and characteristic of the paint being used.

* Stordy Engineering Ltd.

Spray Painting

Spray painting came into its own in the late 1920's with the advent of cellulose-type paints and varnishes, and is probably now the most widely used of all paint-application methods.

Two types of spray gun are in general use, which are generally referred to as external and internal mixing patterns.

With the external-mixing type gun fluid pressures range from a minimum of 5 lb. per square inch on cellulose-type materials up to 20 lb. per sq. in. for some synthetic paints, the equivalent air pressures being between 50 to 70 lb. per sq. in.

With the internal-mixing type gun balanced pressures are required, the fluid pressure, if anything, being slightly higher than the atomizing air pressure. The internal-mixing type gun does show some advantage over its alternative since the reduction in air volume required for atomization can be as low as 50 per cent of that required for the external mixing type.

Except where articles having a large surface area are employed, spray painting by hand methods can be extremely wasteful in paint usage, since it is quite commonly found that as little as 40 per cent of the paint leaving the gun actually finds its way on to the work, the remainder depositing on the walls of the spray booth or being carried away by the exhaust system.

As in the case of dip plant it is vitally necessary to have viscosity control for optimum results and in some installations a centralized paint mixing room is provided for this purpose, the paint then being pumped to the various application points.

Hot Spraying

Within recent years the hot-spray method of painting has been introduced to industry in order to avoid some of the troubles which have obtained with cold spraying methods.

The equipment for hot spraying comprises a pot fitted with thermostatically controlled heating, the paint being raised to a temperature of between 160 to 180°F. With this method it is possible to reduce greatly the amount of thinners necessary since the increase in application temperature will reduce the paint viscosity, and therefore results in less solvent loss.

"Airless" Spraying

Very recently, a new development known as the "airless" spray system has been introduced in this country, although it is in extensive use in the U.S.A.

The system is based on the fact that a sudden release of hydraulic pressure through a properly designed restrictive orifice will break up a heated liquid into small particles. With such a system heat is necessary to lower the viscosity of heavy body paints to a watery consistency to enable a build-up of vapour pressure to bring part of the solvent in the paint to a partial boiling point; since the liquid is under pressure the solvents do not actually boil. Upon the release of these solvents to the atmosphere there is an immediate change of state from liquid to gas, and this vaporization in addition to the high fluid pressure employed, which is between 300 and 600 lb. per sq. in., results in complete atomization. The equipment comprises a high-pressure pump which syphons the paint from the container and at the generated pressure delivers the paint through heating coils, the paint being continuously circulated so that at all times hot material is available at the gun.

Electrostatic Spraying

In recent years electrostatic spraying has found its own place in the finishing field.

In brief, the application of electrostatic spraying for paint is that the components are earthed, generally to the conveyor which carries the workpiece into a highly ionized field, produced by a grid surrounding the part and carrying a negative static pressure of 100,000 volts. Into this field is sprayed the coating material, the finely divided paint particles picking up electrons which are discharged from the negative electrode and which are strongly attracted by the earthed work as it passes through the field, the paint particles giving up their charge on reaching the surface of the earthed component and so building up into a paint film.

With this system, employing most often fixed guns, and with the parts rotating through the field, paint savings of the order of 50 per cent are claimed, but it must be strongly emphasized that the successful application of this system requires the right type of part and a continuous flow of generally similar articles.

A further development of the method just described, known as the No. 2 Process uses, in place of spray guns of conventional pattern, spinning cups into which the paint is pumped, the cups rotating at a speed of approximately 1,000 r.p.m. The paint on the cup is flung off into the field by centrifugal force in a finely divided state being ionized as it leaves the cup and being attracted to the earthed component.

Other specialized and interesting automatic spraying systems are in being, generally for flat ware, though an exception is a system where the work-pieces are automatically rotated in the spraying area, the guns being either of the fixed or oscillating pattern and where extremely high production rates are claimed with virtually no

Fig. 1—View of electrostatic spray booth employing the No. 2 process and used for the finish coating of refrigerator panels.

labour cost, except that required for loading and unloading the conveyor system.

Flow Coating

In essence, a flow coating unit is a shower bath—or thunder storm—of paint directed at the work-pieces as these pass through the paint area on a conveyor system, jets of paint being projected in all directions from nozzles fitted to headers coupled to a pumping system, the excess paint flowing back to a settling tank for re-pumping.

The advantages which flow-coatings installations have over conventional dipping methods can be itemized as:

(i) The comparatively small volume of paint in the system since it is usual for the settling tank to have a capacity only of some 4 to 5 times the pumping rate per minute, thus a pump handling 10 gallons of paint per minute would draw from a settling tank with a capacity of between 40 to 50 gal-

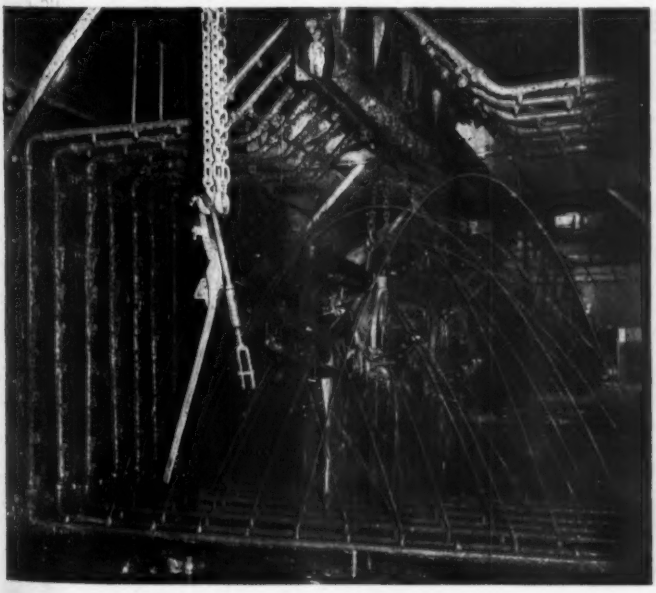


Fig. 2—Actual flow coating of agricultural implements carried from a Monorail conveyor. The flow-coating section can take an implement 12 ft. wide × 6 ft. high.

Fig. 4—Loading end of through-type oven used in connexion with the flow-coating plant for agricultural implements. The oven is of the fully air-circulated type fired by town gas, the air-seal at the entering end is clearly indicated in this view.

lons, which compared to automatic dipping plants is only a fraction of the normal volume which would be required, even for small work.

(ii) Density of loading which, within the limits of the conveyor system, can be as great as that used with hand or automatic dipping methods.

(iii) Work having long drain areas, that is large flat panels, can be flow coated without troublesome runs developing.

While flow coating may not be the complete answer when compared with dip painting for all applications, it has the great advantage of its convenience for fitting into a conveyor system, the jigging of the work to give adequate drainage being similar to that which will be employed for spray cleaning and phosphating when such equipment forms part of the complete conveyor line.

While a flow-coating installation appears to be a simple piece of equipment, and, in essentials, is extremely simple, there are a number of problems which do arise in the successful design and operation of such a plant, and it would be well to consider in greater detail some of these essentials.

It is apparent that with this system the total paint volume will present a large surface area to atmosphere resulting in fairly high solvent evaporation rates and for this reason it is particularly important that the type of jet employed in flow-coating plant is carefully studied.

The paint pressure at the jet will vary with the length of throw and the type of coating material which is being employed, but in the authors' experience should be between pressures of 10 to 20 lb. in the header pipe.

While much useful information can be obtained from pilot plants before the production unit is installed, it is necessary to make due provision in the header pipes for modifications to jet positions to obtain complete coverage under production running, and in some installations it has been found desirable to drill at fairly close pitch the header pipes and plug off intermediate points until the correct jetting pattern has been determined.

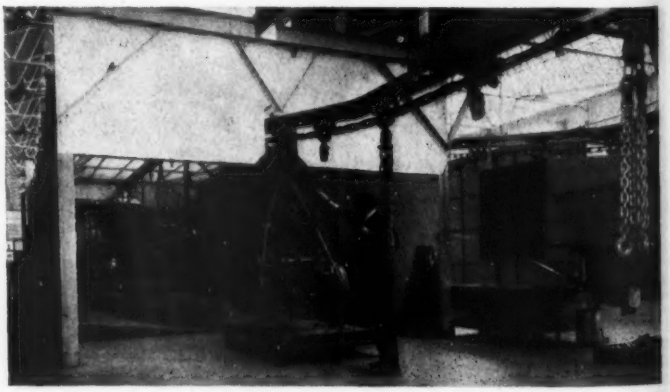


Fig. 3—Discharge end of flow-coating plant for agricultural implements showing the vapour tunnel.

There is some controversy as to whether the main feed to the header pipes should be at high or low level. The authors feel that this is purely a matter of personal preference unless bottom jetting only is to be employed when the feed should be at low level in order to avoid additional pressure necessary to lift the fluid.

It is also most desirable that the header pipes are provided with drain cocks, and some form of union connexion, to enable the complete system to be simply taken apart for maintenance purposes.

The drain area for the actual flow-coating section should be sloped, preferably in all directions, to a drain point with a sufficiency of fall. This should give a preferred minimum slope of 1 in 12. Further, it is of great importance that the actual drain connexion to the paint settling tank is of adequate size. These points have been overlooked in the design of some flow-coating units with disastrous results.

In addition, the return from the flow-coating section should be kept below the liquid level in the paint settling tank to reduce aeration trouble.

With regard to the circulating system, it is generally found necessary that a filter be fitted on the suction side of the pump to protect the pump, and also to prevent undue wear on the pump moving parts and blockage at the jet points. While pot-type strainers are sometimes used, the best form of filter is one of the proprietary self-cleaning types which do reduce maintenance time very considerably.

As in the case of the pumps employed for circulating on dipping systems, pumps employed for flow coaters should be either of the positive-displacement pattern or of the screw pattern running at the slowest possible speed with a by-pass arrangement, preferably delivering back to the paint settling tank.

On the discharge side of the pump a pressure gauge should be fitted together with a valve to regulate the delivery pressure and volume; this valve is also used for maintenance purposes.

In the majority of flow-coat installations two paint settling tanks are provided with a further tank containing solvent, the reason for the duplication of settling tanks being to enable paint to be pumped over from one tank to the other to enable maintenance work to be carried out without interruption to the production operation, the pipework being suitably interconnected, both on the suction, discharge and drain points to permit of such a system being worked. At the completion of a shift the main circulating system is changed over to solvent circulation to enable the whole of the pipework and coating area to be washed down, the contaminated solvent draining back to the solvent tank. In many cases this solvent can be utilized for make-up purposes, though this is not an absolute rule.

Operation of Flow-coating Installations

It has been found in practice that the success or otherwise of flow coating depends to a large extent on the degree of solvent concentration which can be built up in the drain section immediately after the paint application, and for this reason the drain area after flow coating is completely enclosed except for the ends. Since long-tailed oils are essential in the paint formulation to obtain proper flow-out characteristics, if a degree of solvent concentration is present in the drain area then it must follow that the paint will remain open and permit of efficient draining before the actual drying operation. Thus great care must be taken in the design of the enclosed drain area, which should be equivalent to a minimum of ten-minute's travel time, to ensure draught-free conditions, since draughts will cause a rapid setting off of the paint film and will retard flow-out of the paint coating.

Because the solvents employed will present a fire hazard, then extraction, particularly at the entry and exit ends of the flow-coat unit, must be employed and care exercised in the design, not only to prevent the escape of solvent into the surrounding shop area, but also to give the draught-free condition in the solvent-vapour tunnel which is so vital.

Conveyor Systems

Conveyor systems most generally employed on continuous painting plants are either of the monorail pattern or of the flight-bar pattern, or variations of these designs.

In some cases, particularly in the motor-car industry, floor conveyors with the work on trolleys are employed and in some cases slat conveyors are utilized.

The advantage of a flight-bar conveyor over the monorail conveyor is the higher loading density which can be obtained, though against this it is necessary for a loading and unloading operator to be employed and the system does not entirely lend itself to flow production methods for this reason. However, the resultant saving of floor area for production by using a flight-bar conveyor can sometimes more than off-set the cost of labour for the loading and unloading, and many thousand installations of this type are in satisfactory working operation. A flight-bar system also enables selective loading to be obtained with a wide size range within the designed loading capacity.

With a monorail conveyor it is possible to provide hanging jigs so that the work can be either dipped or sprayed without removal from

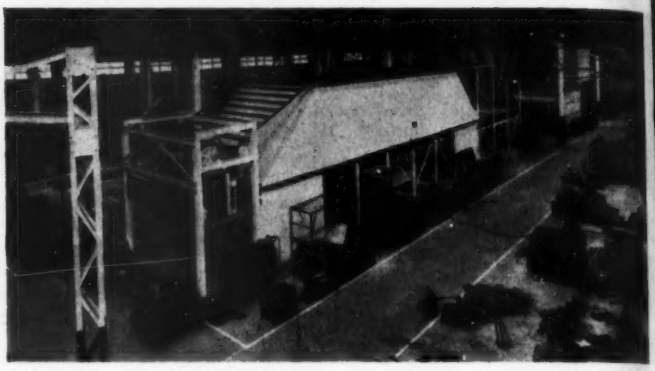


Fig. 5—View of camel-back stoving oven employing crossbar conveyor system used for both dip and sprayed work. The oven is of direct gas-fired fully air-circulated pattern.

the conveyor which then passes through the stoving section and from thence to the storage or assembly areas, the jigs remaining on the conveyor and returning for re-loading. Where dip tanks are used with monorail conveyor systems, then these, generally speaking, will be greater in length than would be the case with a flight-bar conveyor, but will correspondingly be reduced in width. Many ingenious hanging jigs have been devised for the monorail type of conveyor.

Stoving

The majority of paints which are at the present time used in the finishing industry have a synthetic base which requires heat for curing, the actual curing process being known as polymerization and which occurs, in general terms, at temperatures above 240° F and which can be accelerated by an increase in temperature.

However, evaporative-type finishes of the cellulose pattern and also lacquers and varnishes which may be of the evaporative or of the synthetic type are widely used. In any case, an acceleration of drying time or curing can only be accomplished by the application of heat.

There has, in recent years, been much controversy as to the system of heating to be employed, many arguments being put forward both for and against radiant (infra-red) and convection heating systems.

In essence, a radiant system comprises a heat source working at elevated temperature and arranged to direct heat rays at the work-piece, the intensity of heat application varying as the square of the distance of the work-piece from the emitting surfaces, the rapidity of heat application to the work-piece thus being a function of the source temperature and its distance from this source.

The heat energy is projected in a straight line

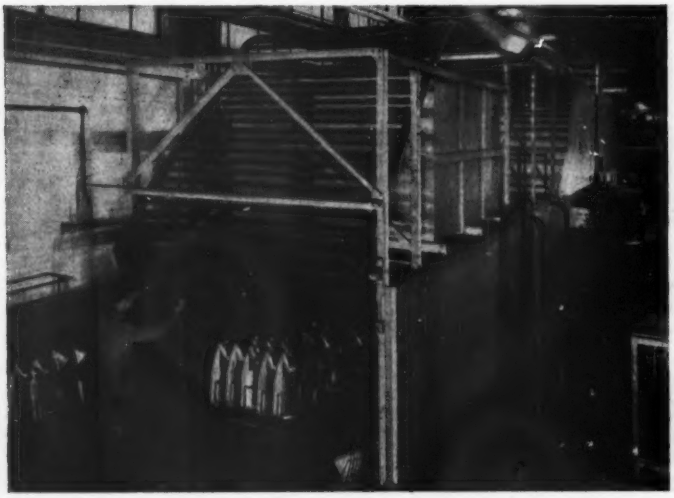


Fig. 6—Loading end of camel-back stoving oven employing automatic dipping, the oven being of the fully air-circulated pattern and heated by high-pressure hot water. Density of crossbar loading can be clearly seen from the illustration.

and it follows that the surfaces of parts or irregular shape will receive a differing heat application depending upon degree of irregularity, and surfaces shielded from direct radiation can only receive the heat necessary for curing by conduction through the base metal. Furthermore, where parts of widely varying section are being stoved, then it must follow that completely different stoving conditions will result.

In the case of an air-circulated system and particularly forced-air circulation, the heating medium is air only which, in a well-designed oven, is arranged to give a highly turbulent condition with consequent rapid heat exchange between the circulating air and the work-piece. With a forced-air circulated system it is possible to limit the temperature lead or head below the spoiling temperature of the work and coating material, so that should for any reason the conveyor system be stopped then the work will not spoil. If a turbulent condition does exist in the drying chamber then equal heat transfer will occur over the whole of the article being dried and, furthermore, since the upper temperature limit is controlled and is not a function of time, work of widely varying cross-section can be stoved with a consistency of result not obtainable in radiant plant. In the majority of forced-air circulating systems direct firing is employed, by which is meant the products of combustion in the case of gaseous fuel are taken directly into the circulating air, thus giving virtually 100 per cent fuel utilization, whereas in the case of radiant heating the heat source is at a considerably higher temperature than that ultimately required by the work-piece with no recirculation and with the waste gases being exhausted at a comparatively high temperature. Furthermore, the radiant unit is, in effect, a heat exchanger which under no circumstances can be 100 per cent efficient, and thus in general terms it can be stated that the fuel cost of radiant plant for a given output will be approximately twice that of a well-designed forced-air circulated system employing direct firing.

Acknowledgements

The authors wish to acknowledge help and information which has been freely given from a number of sources, particularly Alfred Bullows and Sons Ltd., Walsall; T.C. Spray Finishing Systems Ltd., and also for the facilities granted by Mr. H. Dawson of Ransomes, Sims, and Jefferies, Ltd.; and Mr. Geoffrey Sankey of Joseph Sankey and Sons, Ltd., for photographs of flow-coating installations in their works.

DISCUSSION

Opening the discussion Mr. J. N. T. ADCOCK (I.C.I. Ltd., Paints Division) said that he was particularly interested in the statement that it cost twice as much to stove an article by radiant heat as it did by convected heat. Perhaps the authors would give some additional information on this subject during the discussion. He was also glad to note that Mr. Stordy had mentioned that flow coating was not the universal answer to all finishing problems. Mr. Adcock thought that with a flow-coating operation the solvent losses might be higher than in a dipping operation; for example, a figure given in American literature was that for every gallon of paint used 2½ gallons of thinner were lost.

A great deal would depend, of course, on the size and shape of the articles to be flow coated and he asked the authors to distinguish between two types of flow coating where he thought the problem might be rather different. One would be the hit and splash variety (seen in the illustrations to the paper) where a very intricate piece of apparatus was being processed and where a very considerable amount of paint was exposed, and the other type was where a succession of objects all of the same size and shape, were being painted, for example, washing machines or refrigerator shells. In the latter case might it not be possible to "tailor" the flow-coating installation and the jets so as to reduce the amount of paint exposed to the absolute minimum, so improving the flow?

Mr. Adcock then asked for more information on the problems involved in the control of the solvent vapour present. He thought that there must be many difficulties with solvent wash; was accurate control required together with measurement of the solvent vapour or was it sufficient just to have an opening to let the excess solvent vapour out?

Mr. Adcock said that Mr. Appleton had mentioned that solvents had little effect on the final finishing coat. However, he thought that if the solvents were not right some very peculiar finishing coats would be obtained. In reference to airless spraying the authors stated that there was a virtual elimination of solvent, but he thought that the same solvent composition was required as for normal hot spraying, and the same percentage of solvents was also required.

Mr. APPLETON said that he had not seen a demonstration of airless spraying. The information given was from an American paper.

With regard to the question of solvents he assumed that the paint man knew what he was doing; he could not talk with any authority on paint as such.

With regard to the vapour chamber, the ideal was to have some control if possible. Experiments should be carried out until the degree of solvent concentration was such as to give flow-off without washing; by leaving the paint in a heavy concentration of solvent vapour too long, the paint could be washed off. The trouble on the plants with which the authors had been associated was to keep any solvent in at all, because the cross-sectional area was so large that it was virtually impossible to have any control over the solvent whatsoever. He did not know yet of an efficient continuous instrument which would measure solvent concentration. He believed however, that there were such instruments in being.

The jet form used on the installation was one widely used in the U.S.A. It presented a minimum surface area of paint for the particular type of work, but recent discussions with a washing-machine manufacturer for a flow-coating plant for primer, involved the use of a modified form of jet, which presented less surface area than a large number of jets. There was still much to be found out about jet form; the main thing was to avoid spray. With a small jet many troubles could occur and the aim all the time has been to obtain the largest possible jet form, starting off with a $\frac{1}{8}$-in. bore and finishing up with, say, a $\frac{1}{2}$-in. bore.

Referring to solvent loss, Mr. Appleton said that he could recall one unfortunate experience of solvent loss on a plant where a very large solvent addition was made in the first-day's running. That was before the paint was right, and on any flow coater there must be a period of time to get the paint right; in fact a necessary rule was to avoid putting a flow coater into production the day the paint was first pumped. The solvent loss on the paint in that particular plant at the present time was about the same as the best American factories. The loss was about $2\frac{1}{2}$ gallons of solvent to every gallon of paint used, a satisfactory figure. Paint cost was 35s. a gallon and the solvent about one-third of that. As regards radiant heat, Mr. Appleton said that the statement made could be substantiated.

Mr. ADCOCK then asked whether the authors had had any experience of the type of whirling arm, referred to in American journals. He thought that they were used in a sort of standard flow coater.

Mr. STORDY said that with the whirling arm sprayer, the idea was to cover a larger area with fewer sprays, but it divided the paint up very much, and information indicated that it had been discontinued in the States on many plants that had used it, but it was being used in another way for washing dismantled car engines, for degreasing, etc. In general, spray plants had to be tailor-made for the job in hand.

Mr. PODMORE (Joseph Lucas Ltd.) referring to extraction times, said that considering flow coating and dipping together, extraction time could be allied with control of solvent from the dip chamber. He did not think that extraction times should be any specific period if it was possible to control the atmosphere afterwards, and it was just the same with flow coating. He also wanted to know if there was any accurate and automatic method of controlling viscosity of the paint. It was a very serious problem when too much solvent was being lost.

Referring to the cost of flow coating, Mr. Podmore said that it would appear that having so many pumps in operation would make maintenance costs so much higher; he then asked the authors for information on the economics of the process and the thickness of coat with flow coating as compared with conventional dipping.

He said he was rather surprised to hear the authors say that it was customary these days to use direct-fired ovens for painting installations. He would have thought that indirect firing would be used. He asked for some comparative figures on the efficiency of indirect and direct firing. Mr. Podmore then asked whether the figure given in the paper for the speed of rotation of the cups in the No. 2 Ransburg process was correct.

Mr. APPLETON, said that as regards the question of extraction time and control of solvent, he was in complete agreement with Mr. Podmore, though it was only comparatively recently that the importance of a solvent concentration immediately after painting was fully appreciated.

Viscosity, he went on, in a flow-coating plant, and sometimes on paint dip plants, could be a very considerable problem, and he was at the present time actively investigating the cost of automatic viscosity control, although particularly on smaller-type installation, with the information which so far had been obtained, the instrumentation would be extremely expensive, and it would be necessary accurately to control the temperature, not only of the paint but of the shop in which it was situated.

In regard to the cost of flow coating, experience was that maintenance on pumps was a very small item indeed, the biggest maintenance being in connexion with the filters which, as had been mentioned in the paper, should be of the self-cleaning pattern.

Mr. Appleton said he was unable to answer the question on the thickness of coat with a flow-coating plant as compared with conventional dipping plant, but he understood that provided

that the vapour tunnel was effective, then it was possible to obtain surprising evenness of thickness of coating over quite large articles.

On the question of direct-fired ovens, as opposed to indirect-fired ovens, he would say without hesitation, that when using gas as the fuel some 90 per cent of the plants with which he had been associated had utilized direct firing, *i.e.* a combustion chamber remote from the oven working space, coupled directly to the circulating fan which delivered to the work chamber a mixture of products plus recirculated air. Such a system ensured that 100 per cent of the heat energy released by combustion was available for useful work. If, however, and as was sometimes required due to the type of coating material being used, an indirect-fired system is used, then it suffered from the disadvantage of a heat exchanger which under no condition could be 100 per cent efficient.

For certain types of coating it was possible to use direct firing even with fuel oil and without trouble, though generally speaking direct fuel-oil-fired ovens were not used for finish coats but for prime coats. Where an oil-fired installation was required for finish coats, then almost certainly he would recommend an indirect-fired system in order to prevent trouble due to dirt spots carried over during the heating-up stage of combustion. His remarks certainly applied in the case of radiant heating where of necessity an interchanger was required in order to obtain the radiant effect, and which, in the case of a gas-fired installation, might have a panel temperature of 650°F. or higher, with a flue-gas temperature very much in excess of this.

The speed of the cups used on the installation which Mr. Stordy described in the paper was definitely 960 r.p.m.

Mr. PODMORE said that he agreed with Mr. Appleton on his observations on radiant heat, and he would not contemplate using a radiant-heat stove if there was any other way out. What he did was to use the indirect gas-fired one. Commenting further on solvent control, he said that for dipping he used a very short extraction time of somewhere in the region of 5 seconds, but he found it necessary to control the next 10 seconds very carefully. The obvious advantage, as he saw it, with flow coating, was the appreciable reduction in the size of the paint tank, and also the advantage of getting into areas which would otherwise be left bare by air locking, etc.

Mr. BRADSHAW (Tube Products Ltd.) said that the efficiency of direct-fired ovens must be greater than indirect-fired ovens, but he had always had a personal fear with oil, where with direct firing there was a danger of firing the stove due to particles of unburned oil getting through. He knew from experience of such fires that oil burners had improved atomization, but he presumed that even the best-regulated burners would sometimes give trouble; had that danger been entirely overcome nowadays?

Mr. STORDY, said that the danger had been entirely overcome with reasonable maintenance. An oil burner would not burn for ever without maintenance, but the discussion was about plants which were burning 35-seconds oil. He would not recommend an oven being installed with direct oil firing with 200-seconds or 900-seconds oil, particularly if it was to be used for colours. His company were finding it necessary to install many ovens with interchangers because they were to be used for pastel colours, and for roller-coated paints, but an interchanger would not be put in unless the process demanded it.

Mr. PARKES (Docker Bros. Ltd.) said that he agreed with the remarks made about radiant heat, and also the statement that a convection-fired oven burnt half the amount of fuel of a radiant-heat plant, but it should not be overlooked that putting an article through a gas-fired radiant heat oven would give a much quicker stoving time.

Mr. APPLETON, said that with a radiant plant the panel temperature was very considerably higher than the temperature required on the work, thus for a stoving temperature on the article of 250°F the radiant panel would probably be at 650°F. If a convection system was run at a corresponding temperature, then he would suggest that times as fast, or possibly faster, than those obtained with a radiant plant would be found though, of course, with all the disadvantages magnified.

Mr. CHEAL (John Wright and Co. Ltd.) said that his company needed to apply seven different colours. Could the authors offer any suggestions for a suitable method?

Mr. STORDY said that on the face of it, it seemed that flow coating would not be satisfactory. If the articles were small continuous dipping might also be difficult, because it might be necessary to have a divided dip tank which could be moved over. It would be preferable to use less colours and flow coating, which would result in substantial savings.

Mr. APPLETON stressed the fact that flow coating was not being advanced as one complete answer to all problems, and that was why the authors had also discussed dipping, spraying and flow coating; the same remarks applied to airless spraying, hot spraying and electrostatic spraying.

Mr. PARKES (Docker Bros. Ltd.) asked whether the authors could give a rough guide as to when

(*Continued in page 22*)

Modern Painting and Stoving Techniques
(*Continued from page 21*)

a dipping conveyor plant became economic, that is the number of articles to be handled per day?

Mr. STORDY said the answer was really a question of economics, *e.g.* how much paint could be tied up in the tank, and that was left to the user to decide.

Mr. PARKES said that if somebody required a direct-fired plant to do 500 articles a day, was it economic or not?

The CHAIRMAN suggested that the economics of any paint process was dependent on the paint price.

A speaker (Cellon Ltd.) asked whether it was possible to give a general statement on the type of articles which could be economically flow coated. Could any observations be made on the application of air drying by flow coating? The question of solvent loss, even though the solvent was cheap, was important and was bound to effect the economics of the process.

Mr. STORDY said that what could be dipped could be flow coated, but that did not mean that what could be dipped should be flow coated. Very often the process finally used depended on whether it fitted in with the rest of the production line, and if it was possible to arrange articles on a monorail conveyor and put them through a cleaning process and then through a painting and a drying process, etc. He did not think that whether a particular paint application process was the cheapest was necessarily the determining factor.

A speaker (Lewis Berger and Co. Ltd.) said that he wondered why, as regards solvent loss in the vapour take-off tunnel, the principle suggested by the authors had not been applied in other ovens. The authors advocated hump-back ovens, but why not use a tunnel trough to keep in the heavier solvent vapours?

Mr. APPLETON said he had thought of using a hump-back oven as a flow coater and then it suddenly occurred to him that since the solvents were heavier than air, instead of keeping them in, the method provided the ideal way of getting them out. A solution would be to put the oven upside down but no one had designed such a plant so far. This design, however, would produce ideal conditions, that is, heavy concentration immediately after application of the paint with a decreasing solvent concentration as the parts approached the stoving oven.

Mr. PODMORE said that the solvent loss obtained with dipping or flow coating, would appear to be the greater with flow coating; had the authors considered the use of the catalytic oven?

Mr. STORDY said that he had gone into this question on quite a number of plants and in great detail, but an installation had not yet been made because tests of solvent concentration had not proved it to be economic. He did not think it possible to provide the solvent concentration required to make the plant work as there were certain dangers involved.

U.S. SPECIFICATIONS AND TESTS FOR ELECTRODEPOSITED COATINGS

THIS compilation of 17 specifications, methods of test, and recommended practices embodies the work of ASTM Committee B-8 on Electrodeposited Metallic Coatings. These ASTM Standards in the field of electrodeposition of metals have either been developed jointly with the American Electroplaters Society, or have had subsequent endorsement by this group.

The book contains specifications for zinc, cadmium, nickel-chromium, and lead on steel; nickel-chromium on copper; nickel-chromium on zinc; and chromate finishes on zinc coatings. In addition there are recommended practices for preparation of low-carbon steel, high-carbon steel, zinc-base die castings, and copper-base alloys for electroplating; chromium plating on steels; and preparation of and electroplating on stainless steel and aluminium alloys. Methods of test include test for local thickness and two spray tests—the salt spray and the acetic acid-salt spray.

Copies of this 104 page compilation are available from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pa., at $1.85.

Automatic Nickel-Chromium Plating Line at Luton Works of Vauxhall Motors Ltd.
(*Continued from page 12*)

comparatively large components are put through with others of smaller area. All racks have been designed, as far as possible, to carry the same effective plating surface area and within limits this is achieved.

All operating conditions are controlled from a central office at the side of the plant where any discrepancies can be immediately adjusted.

Acknowledgments

We are indebted to W. Canning and Co. Ltd., the manufacturers of the plant, for assistance in the preparation of this description, and to the directors of Vauxhall Motors Ltd., for permission to publish it. In particular, Mr. E. H. Moorey, of the latter company has assisted with much helpful comment.

A Comparative Survey of STOVING by CONVECTION and RADIATION

by LEO WALTER, A.M.I.Mech.E., M.Inst.F.

(*Continued from page 451, October, 1955*)

STOVING BY RADIATION USING GAS-HEATED EMITTERS

IN the years following the war considerable research and development of radiant stoving was undertaken by makers of paints, lacquers and enamels and also by manufacturers of radiant-heating elements and of stoves. The result has been a definite improvement in industrial finishes for large- and small-size metal products subjected to radiant stoving. The essential prerequisites to stoving, namely cleaning, pretreatment in one form or another and application of the coating material have also been improved, and some new efficient methods have been introduced. To produce a finish at a precise specification obviously requires that all processing procedures are performed according to a strict schedule, otherwise the last process, namely stoving could not be expected to be as perfect as desired. Demonstration centres and test laboratories have been set up by makers of paints and lacquers, and by stove manufacturers to enable a prospective customer to carry out practical tests with articles of different shapes, and after various pre-treatment procedures, using several suggested or desired coating materials (Fig. 1). To enable a user of a new method of stoving to see for himself results likely to be expected later in his own plant a series of pilot-tests seemed always the most satisfactory method to avoid disappointment. Temperatures, curing time, the method of coating, flash-off period and other factors influencing the appearance of the finish can thus be ensured before a definite order has been placed for new equipment. Apart from other points which made such test and demonstration centres necessary was the unfortunate fact that it seems to be particular to finishing operations that many users apply "hush-hush" secrecy to their finishing plant. Fierce competition seems rather prevalent in this trade instead of co-operation and an "open-house", as encountered in other branches of industry (Fig. 1A).

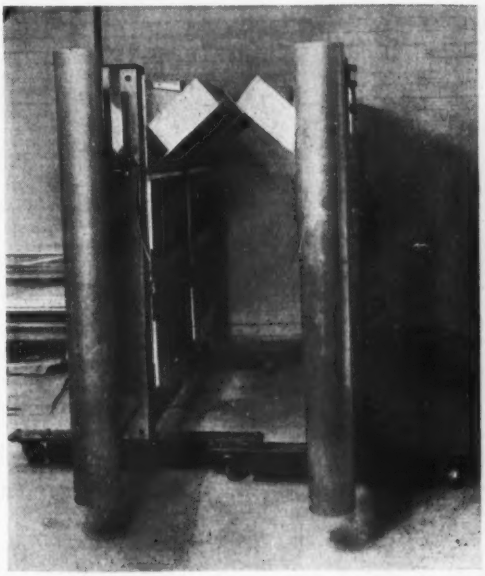


Fig. 1.—Pilot plant for experiments with Bratt Colbran panels.

(Courtesy of Bratt Colbran Ltd.)

In the following paragraphs, examples of practical uses of radiant stoving will be given, selected at random from "case histories", placed at the author's disposal by manufacturers of radiant ovens, and by some of the more progressive of the users of radiant equipment, who are not afraid of "disclosing" particulars of their stoving plant.

Gas Heat for Radiant Stoving

There is nothing fundamentally new in the use of radiant heat emitted from gas-heated sources. Medium-temperature black-emitter panels and high-temperature incandescent heaters have been applied for stoving a sufficiently long time to overcome all initial "teething troubles" encountered in all new developments.

Fig. 1A.—Plant installed at the works of Donald McPherson and Co. Ltd., Mitcham. The heating panels consist of 24 Bratt Colbran industrial units; the temperature is controlled by Electroflo equipment. The plant is fully adjustable for proving customers' samples. The heating units are mounted on castors to give full adjustability.

The medium-temperature range is usually from 450 to 650° F. (232 to 343° C.) with up to 900° F. (482° C.) sometimes used. The high-temperature range is between 600 and 1,000° C. (1,100 to 1,800° F.). The unit of measurement for radiation is 1Å or Angstrom unit. The flux density as a measure of intensity of radiation is measured in B.Th.U. per sq. ft. per hour. For example for a tunnel stove with panels at 650° F. the flux density is about 4,000 B.Th.U. per sq. ft. per hour. For incandescent heat sources this figure rises to about 50,000. Much more could be said about technical and technological details, but the potential user of gas heat for stoving purposes has little influence on emitter or stove design.

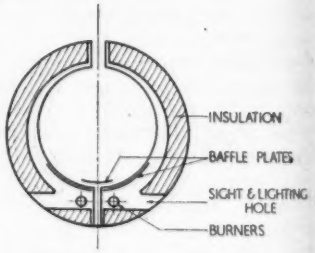
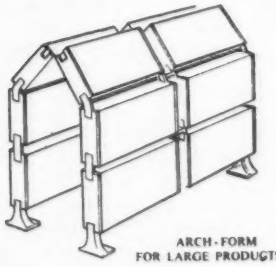
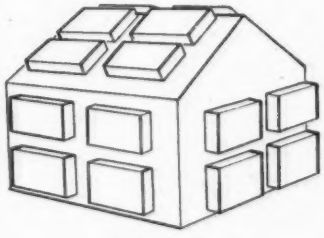
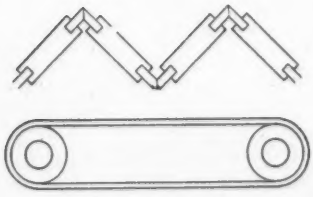


Fig. 2 (above). — Cross-sectional diagram of older type of gas-fired radiant - heat oven.







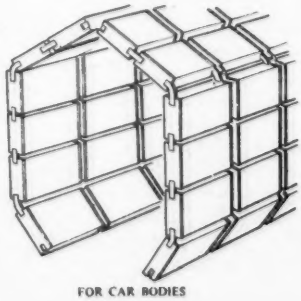


Fig. 2A (left).—Some suggested uses of Parkinson Cowan radiant panels.
(Courtesy of Parkinson and Cowan Ltd.)

He states to the oven maker his requirements, and leaves it to the experienced stove designer to do his best to produce desirable results. The main question, however, which is always in the user's mind is whether he will dry at maximum possible output at minimum cost per unit. The choice of gas as a heating medium is, of course, in the first instance influenced by availability. Next comes the question whether to use town gas, or electricity supplied from the grid. The author does not intend here to take sides. Both heating media have their decided advantages under certain working conditions. The industrial engineer attached to area gas boards is probably the best person to be contacted at an early stage, and similarly the advice of the local electricity board can be sought. A healthy competition between these two possible suppliers of the heating medium will not only make available to a new potential user of radiant stoving the vast experience accumulated over the years by both public bodies, but will also (in co-operation with the maker of the stove) disclose more or less exact figures for gas or power consumption, tariff concessions, and ultimately the cost per unit stoved. There may be instances, however, where the services of an unbiased expert may become advisable. Although intensive study of the literature indicated at the end of this article can give most valuable information to a future user of a radiant stoving plant, an unbiased expert has usually very special knowledge and experience which cannot be found anywhere in print.

If it is assumed that in a particular case the ultimate decision was in favour of gas heating, the following examples will show what can be done by using the right type of gas-heated emitters, the correct method of working the plant, and achievements when following the advice of people who are "in the know".

A Few Practical Examples of Gas Heating

Efficient techniques for the successful processing of a wide range of goods have been developed by makers of gas-heated radiant stoves. At the same time advances in metal-finishing methods and the systematic study of paints most suitable for radiant stoving exclude any failure if the potential user clearly states his requirements.

Fig. 2 illustrates a cross-section of the original type of a gas-heated radiant conveyor oven, circular in cross-section and comparatively small in diameter. Later other designs were produced whereby the cross-section of the stove was designed to suit the shape of the goods to be stoved. Either gas-heated or electrically-heated panel units were made in several standard sizes, and incorporated in the stove design according to requirements. Each stove manufacturer has, of course, his own ideas about number and size of panel units. As an example, Fig. 2A illustrates a few suggested gas-heated arrangements by a well-known maker. It is claimed that for certain instances where standard 2-ft., 3-ft., and 4-ft. diameter infra-red tunnels cannot be applied, the panels of 36-in. × 18-in. area are suitable for handling intricate shapes of goods. By connecting a sensitive thermocouple to the centre of each panel, correct temperature measurement

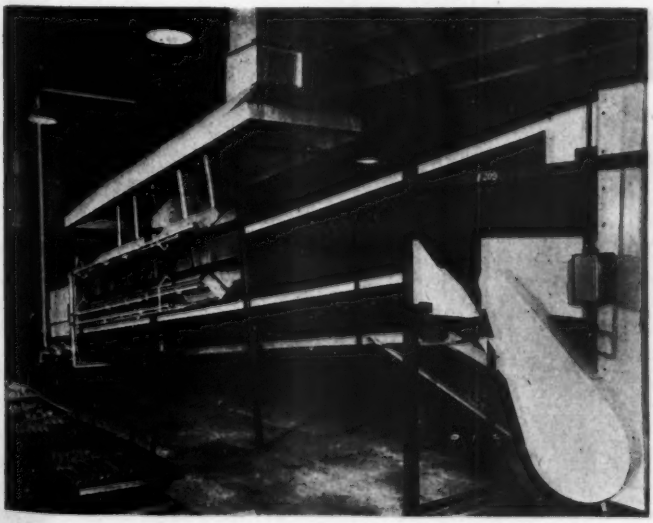


Fig. 3.—Infra-red drying of dipped electrical fittings at the works of F. C. Blackwell and Co. Ltd., Great Crosby.

(Courtesy of Thomas De La Rue and Co. Ltd.)

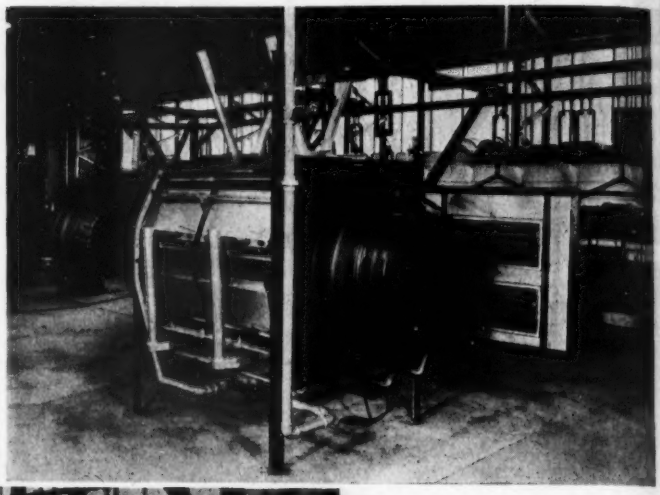


Fig. 4 (right).—Infra-red drying of steel beer-barrels using gas-heated elements manufactured by Thomas De La Rue and Co. Ltd.
(Courtesy of Metal Containers Ltd.)

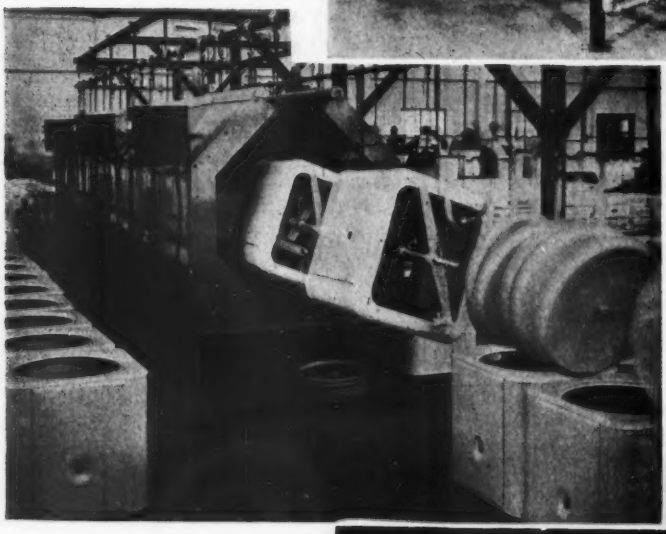


Fig. 5 (left).—Gas-heated plant using Bratt Colbran emitters at the works of the British Vacuum Cleaner and Engineering Co. Ltd., Edinburgh. Two ovens are available, each of 54 units, for the stoving of Goblin washing-machine components.
(Courtesy of Bratt Colbran Ltd.)

Fig. 5A (right). — Paint-drying plant at the works of the British Vacuum Cleaner and Engineering Co. Ltd. The drying time is about 5 min., and the components are carried through the oven by a Teleflex conveyor, 96 ft. long and having 48 carriers. Three Electroflo temperature indicators are provided giving temperature readings at 18 different locations.
(Courtesy of Bratt Colbran Ltd.)

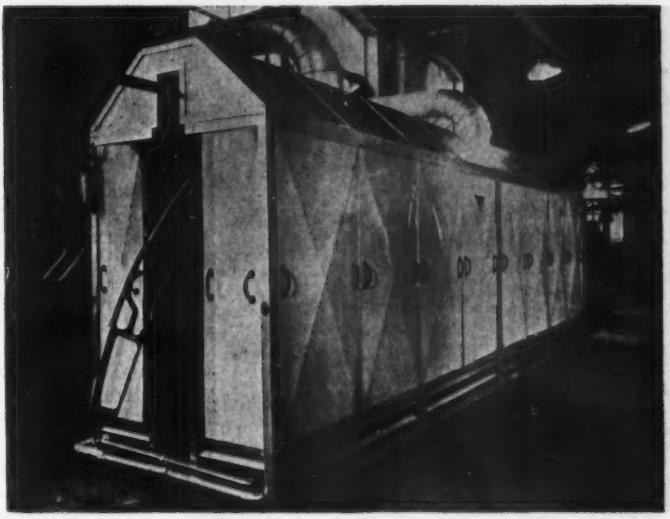


Fig. 6.—Plant installed by Aerospray Ltd., for well-known car manufacturer using 48 industrial units.
(Courtesy of Bratt Colbran Ltd.)

can be obtained for each zone. Products of combustion are discharged from the top of each panel into the heated zone for additional convection heat. The average panel temperature is 650° F., with 4.5 sq. ft. of radiant area. Gas consumption is about 50 cu. ft., of town gas per hour at 1.1-in. W.G. pressure.

A plant in successful operation at F. C. Blackwell and Co. Ltd., of Great Crosby is shown in Fig. 3. It uses De La Rue infra-red heating panels and has been installed for the dipping and curing of electric-light fittings, conduits, elbows, junction boxes, etc. The design of the equipment is rather unusual in as much as it conveys, on flight bars, trays of fittings which are cured by downward radiation from the infra-red panels fitted at the top of the oven, and hanging from the same flight bars are further components which are cured by upward radiation from the lower section of the oven.

The tunnel contains a total of 30 De La Rue infra-red panels. Dipping, draining and curing is fully automatic, and the time cycle of nine minutes through the oven produces a very satisfactory finish. It will be appreciated that some of these fittings and castings are of fairly heavy section, while others—caps of junction boxes for instance—are of pressed steel, and care has been taken with paint formulation to ensure that breakdown of paint film does not occur over the extended cycle on the lightweight materials, while ensuring that a full cure is obtained on the heavy components. Overall consumption of the oven is 660 cu. ft. of 500 C.V. gas per hour.

Another interesting gas-heated radiant stoving plant applying De La Rue emitters is in successful operation at Metal Containers Ltd., in their Ellesmere Port Works. This piece of equipment was designed to cure various coloured paints on stainless-steel barrels weighing 300 lb. each (Fig. 4). As the photograph shows the barrels were designed with a deep re-entry at top and bottom and it was essential for curing at these points to be complete. The equipment was, therefore, designed to convey the barrel into the oven which was fitted with swing doors each holding two emitters, the doors being closed while curing was effected.

The oven comprises of 20 emitters which follow as closely as possible the profile of the barrel. The conveyor is tripped to stop and go at cycles of 6 minutes, the doors being hand-operated. Normally consumption would be 440 cu. ft. per hour of 500 C.V. gas, but owing to the fact that the barrel ends are protected against damage in use (through careless loading and unloading) by a wooden compound bolster (which is made of sawdust bonded with a synthetic resin) it was necessary to lower the flux density on this oven and the governor is set to give an overall consumption of 320 cu. ft. per hour. It should be realized that with a closed oven of this type the convection addition is an important factor in raising this mass of metal to curing temperature in 6 minutes.

A typical paint drying tunnel using Bratt Colbran radiant elements is illustrated in Figs. 5 and 5A. It is in operation at the works of British Vacuum Cleaner and Engineering Co. Ltd., at Broxburne, Edinburgh, and comprises 48 emitter units. It is used for stoving ing white enamel on washing machines of the

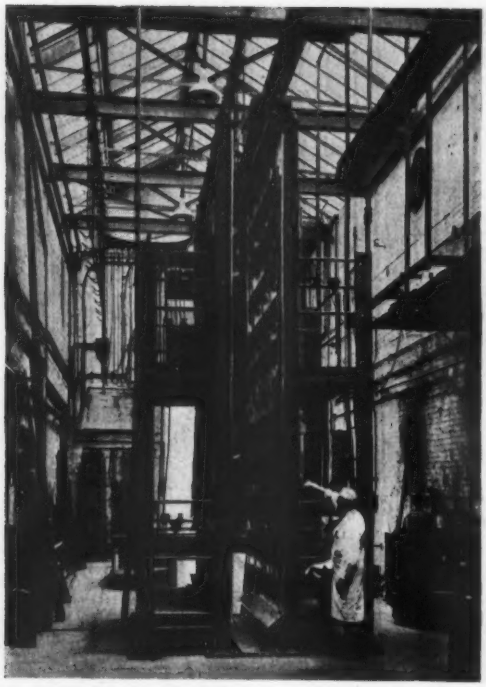


Fig. 7.—Infra-red panels for drying framework sections of steel buildings.
(Courtesy of The Gas Council.)

"Goblin" type. An overhead conveyor system is used, as shown. Fig. 6 shows a completely enclosed continuous conveyor oven for stoving motor-car components. It should be noted that this oven is dealing in practice with articles covering a wide range of weight and surface area. This is an instance where an oven composed of sections of emitters is capable of certain adjustments (within limits) to cope with variations. For example, the heat input to a range of emitters can be readjusted and balanced to produce uniform effects of radiation over the whole surface of the stoved articles. Zoning is also a widely used means to produce a desired temperature-time curve during movement of the goods through a tunnel.

A few examples of stoving times achieved with equipment made by Parkinson and Cowan Ltd., of London, E.C.1, have been tabulated in Table I.

Fig. 7 shows an interesting installation for infra-red drying and baking of coatings on steel frames used for building purposes. Town gas is used in a number of infra-red drying elements located at both sides. During the slow passage of each frame, radiant-heat rays perform quick

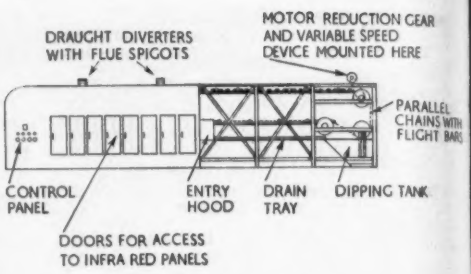

DRAUGHT DIVERTERS WITH FLUE SPIGOTS
MOTOR REDUCTION GEAR AND VARIABLE SPEED DEVICE MOUNTED HERE
PARALLEL CHAINS WITH FLIGHT BARS
CONTROL PANEL
ENTRY HOOD
DRAIN TRAY
DIPPING TANK
DOORS FOR ACCESS TO INFRA RED PANELS

Fig. 8.—General layout diagram of continuous dip coating and infra-red baking plant.
(Courtesy of Stewart Gill and Co. Ltd.)

and uniform drying at the maximum allowable rate. The user claims that savings of time and money for this drying operation is considerable, when compared with any other hot-air drying method.

Design engineers should be well aware of the great possibilities which radiant heat provides for drying of very large metal parts having had a paint or lacquer coating, or other coatings requiring heat for drying. There is, however, one point to be observed when designing metal components which should be subjected to radiant drying methods, namely "shaded" areas must be avoided in the design (Fig. 8). This is particularly important when continuous radiant drying is employed, whereby the components hang on overhead conveyors, monorails, and the like during their passage through radiant drying tunnels. In case the design of the articles is not flat and has cavities or recesses which prevent the heat rays from falling on them at a desirable angle, a second drying operation might become necessary, whereby the components have to be hung differently. This complicates matters, and it is by far preferable to have the design of the

TABLE I

Stoving Times for Parkinson and Cowan Gas-heated Infra-red Equipment.

User.	*Plant.*	*Stoving Time in Minutes*
Home Ease Ltd.	40 Panel Units for Stoving Ironing Board Frames.	4
Power-Samas Ltd.	48 Panel Units for Cases of Accounting Machines and Cast Legs with Wrinkle Finish.	10 25
Rover Co. Ltd.	24 Panel Unit for Primer Coat on Land Rover Body	8–10
Tanks and Drums Ltd.	4 Unit Tunnel 3-ft. dia. for 5-gall. Drums.	5
Brockhouse Engrg. Co. Ltd.	Three 4-ft. dia. Tunnels for drying Miniature Frames for Motor Cycles.	8
City of Birmingham	Two 3-ft. dia. Tunnels Stoving Enamelled Street Designs.	5

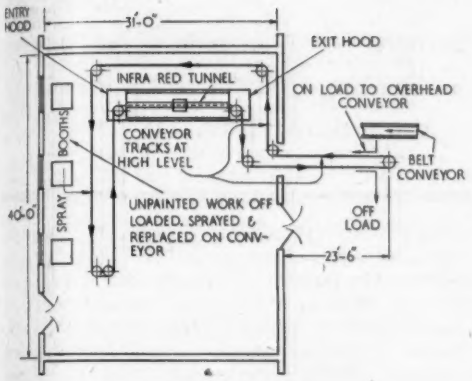


Fig. 9.—Diagram of layout of gas-heated continuous radiant paint-baking plant with conveyor system. (*Courtesy of Stewart Gill and Co. Ltd.*)

article to be stoved adapted to this otherwise highly efficient drying method.

This brief survey would be incomplete without mentioning gas-heated high-temperature plants. Special designs of tunnel stoves with direct heating are in use, and so are indirectly heated (muffle-type) ovens. For example a typical directly heated conveyor furnace has a row of non-bunsen type burners which supply heat from radiant bars on one side and use insulating refractory brickwork on the other side. The effect is that the actual heating takes place between two gas fires facing one another.

An indirectly gas-fired muffle conveyor furnace has the hot gases confined between refractory material and a muffle wall made from heat-resisting cast iron or steel. Up to 1,000° C. can thus be achieved, and a conveyor system runs through the furnace base (Fig. 9).

As far as metal finishing and paint curing is concerned, medium-temperature tunnels and radiant emitter panels are applied in the majority of cases. It is claimed that one advantage of using a black-emitter tunnel for stoving is the possibility of drying all colours in approximately the same time. The reason for this fact is that the wavelength produced is not selectively absorbed, *i.e.*, from white to black the drying effect remains practically the same. Makers of gas-fired emitters claim that panels are capable of giving a radiant flux density from 4,000 up to about 10,000 B.Th.U. per sq. ft. per hour, and can be robustly constructed from sheet steel, protected by a heat-resistant refractory coating, and backed by an insulating material, such as asbestos. The burner can be a float carrying a number of gas jets, keeping the panel surface at a uniform temperature. Accessibility of burners

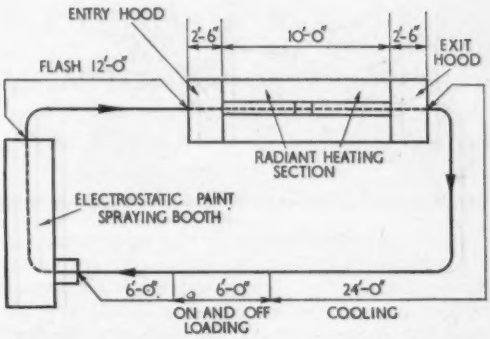


Fig. 10.—Diagram of continuous electrostatic paint-spraying and infra-red baking plant with entry and exit hoods.

facilitates inspection and re-jetting, and modern panel designs allow easy replacement of every part at moderate cost.

In a paper by H. R. Hill (*see* Bibliography) the author describes the advantages of gas-heated tunnels or ovens incorporating Bratt-Colbran emitter units as follows: "(a) Ability to vary the temperature of individual units, or a number or line of units in an oven, to allow for differences in metal thickness in order to provide great flexibility; (b) Oven shape can conform with work shape resulting in a much wider range of application, *i.e.*, large flat metal sheets; (c) With flexible construction the oven shape can be changed; (d) Where minimum floor space is required a tower oven with vertical conveyor and very small base may be used. If a horizontal tunnel is necessary, and space is limited, it can occupy a corner in the workshop. (e) The discharge of hot products of combustion into the oven increases the efficiency" (Fig. 10).

In their excellent paper on design and uses of town gas for H.T. radiant heating, Lockwood and Davies (*see* Bibliography) put the following questions to discussion of considerations that must be given to every application of radiant heating:

"(1) the present method of heating;
(2) any difficulties experienced with this method;
(3) the required output;
(4) whether operation is in batches or continuous;
(5) the amount of labour involved in handling;
(6) the temperature to be attained in or on the article and also how critical this tem-

(*Continued in page 34*)

A Quarterly Survey of some of the Features in Finishing Literature from Abroad

by **SCRUTATOR**

THE past year has seen the first large-scale movement towards an increased use of zinc-base die castings on American passenger-car grilles since immediately before World War II. Out of twenty-one different designs, thirteen employ zinc-base die castings and the 1955 Chrysler Imperial and Buick grilles contain 25 lb. of alloy each. This constitutes a major change for the Chrysler line which incorporated no zinc in its 1954 cars. Platers in this country will be interested to learn that one of the principal reasons for this trend is believed to be the ease of plating coupled with the high quality appearance of the finished article(1). It also reflects, of course, the American automobile industry's confidence in the stability of zinc supplies and prices.

Organic Finishing

Advances in the application of organic finishes are relatively few and far between but two methods which are currently attracting considerable interest both here and in America are " flow coating " and " airless spray painting." In the initial stages of most " new " developments one usually finds that considerably more sales-guff is available than accurate technical information. It is heartening to report therefore that good surveys of both techniques, with particular reference to American practice have recently been published. Zahn(2), organic finishing engineer at General Electric (new appliances), Louisville, Kentucky, points out that far from being a new process, flow coating was used on both early model " T " Ford and Dodge cars. The present-day demands for method economy and the advantages of being completely automatic and thus easily inter-connected to fully automatic cleaning, painting and stoving lines, coupled with low space and working paint volume requirements, have brought flow coating right back into the industrial picture. It is used by the entire American major appliance industry, has made rapid strides during the last 3 to 4 years in the farm equipment, room cooler and metal furniture manufacturing industries and is receiving serious consideration from car manufacturers for painting body skeletons.

In airless spray painting, the paint is heated and a fraction of the solvent brought close to its boiling point. Atomization is produced by the sudden release of the internal expansion forces so produced. Some technical data on the process is presented by Bede(3) who stresses that it dispenses with the necessity for a spray booth, ventilation requirements being solely to remove solvent fumes, markedly reduces paint over-spray losses, enables a heavier coating to be applied in one operation and is particularly suited for maintenance painting. Nevertheless, Ransburg No. 2 electrostatic painting has recently been introduced by Studebaker, Indiana for coating passenger-car chassis ! !(4).

Coatings for Metals

The scope of flame spraying has been extended to the application of ceramic coatings consisting of pure metal oxides(5). The ceramic material (principally aluminium and zirconium oxides) is melted in the gun, sprayed with an air-blast and reaches the surface being sprayed in a semi-molten condition. In the Norton Co.'s process a sintered cermic rod is fed through the spray gun to produce their " Rokide " coatings, whereas the Armour Research Foundation's treatment uses a powder. The coatings are claimed to withstand temperatures up to 3,000° F. and erosion by gases at supersonic velocities. Although they are too new to have been given extensive field trials, if their initial promise is confirmed they should find applications for rocket, missile and jet-engine components.

Pre-coated steel sheet or strip carrying a relatively thin electrodeposited metallic layer has been marketed for many years, but a newcomer has recently made its appearance in America.(6) This is steel sheet or plate pre-plated on one or both sides with a relatively thick nickel deposit (nominally of 6 to 8 mil. on sheet and 8 to 10 mil. on plate, although thicknesses of 15 to 20 mil. can be obtained). Both sheet (0.077 to 0.184 in. thick) and plate (3/16 to 1 in.) are available in widths up to 80 in. and lengths up to 20 ft. This nickel-plated steel will probably be of value to the process equipment industry for applications where a high degree of corrosion resistance is desired, particularly to avoid product contamination. No special equipment for fabrication is required and it has, of course, a considerable price advantage over more conventional materials such as stainless

(*Continued in page* 34)

A Students Guide to Examination Courses in Metal Finishing

II. Intermediate (*Cont.*)

Compiled by A. ALEXANDER

Lack of success in passing examinations arises almost as frequently from failure to apply knowledge properly as from failure to acquire knowledge. This series of articles is intended to assist actual and intending entrants for the City and Guilds Certificate Examinations in Metal Finishing to answer examination questions in the most effective manner.

(*Series continued from page 537, December, 1955*)

PHOSPHATE AND OTHER COATINGS FOR STEEL

Phosphate Coatings

PHOSPHATE coatings are used considerably in industry and a candidate for the examination should be aware of the general principles involved and of the basic types of coatings used.

Speaking generally the coatings are applied by dipping the steel articles into a solution containing phosphoric acid, together with one or more primary phosphates. Phosphates of iron, manganese or zinc are used. The phosphating solution attacks the surface of the article forming a coating of phosphate on the surface. This coating is adherent but somewhat porous. The coating itself, therefore, does not give complete protection to the underlying metal surface but is an extremely useful base for paint, oil or some other protective medium.

The original process was known as Coslettising and involved the use of a solution of zinc phosphate in phosphoric acid. The solution was used boiling, the time of treatment being about two hours. This produced a greyish type of coating on the surface which could be impregnated with a suitable oil or paint. The process, however, was far too slow for modern purposes and in order to speed it up "accelerators" were added to the solution. These consist of oxidizing agents which probably function by oxidizing the hydrogen evolved at the metal surface. Strong oxidizing agents, however, cannot be used since they upset the balance of the solution and the usual accelerators are such substances as sodium nitrate, copper salts and chlorates.

Most of the commercial processes today are proprietary and are known by various trade names. Parkerizing uses a solution of acid manganese phosphate. Bonderizing which is used as an undercoat for paint, uses zinc phosphates and accelerators and Granodizing is similar in nature. The solutions are normally used near the boiling point, although in some cases solutions can be made to run at lower temperatures. The article to be treated is first thoroughly cleaned and then dipped into the solution. Where, however, dipping is impracticable or difficult, these processes can be applied by spraying the solution on to the article.

The exact mechanism of the formation of the coating is somewhat outside the Intermediate syllabus. Speaking broadly, some of the iron dissolves in the bath and is replaced by one of the coating metals or, in the case of solutions using ferrous salts by a layer of iron phosphate. The coating iself is crystalline in nature, the size of the crystals varying very considerably with the operating conditions of the process concerned. In some cases the coatings are dyed to make them an even black and improve their appearance, and may be then impregnated with linseed oil or a good mineral oil. Rinsing the coating in a weak chromic acid prior to impregnation is claimed to improve corrosion resistance.

These processes are of considerable commercial importance, they are very largely used to protect iron and steel articles, particularly when they have subsequently to be painted. The process has the advantage that it is relatively cheap to apply and is reasonably easy to control. The appearance of the article, if not painted, can be considerably improved by dyeing and oiling, which gives a pleasant black finish suitable for machine parts, etc.

Oxide Finishes on Steel

A number of other finishes for steel, depending on the formation of a thin film on the surface are used for various purposes. The most common of these depend on films of oxide.

One of the earliest of these processes was the Bower-Barff, in which the steel article is heated to about 800°C for 20 minutes, first in contact with air and then in super-heated steam. After this the heating is continued in an oxidizing atmosphere which produces an adhesive layer of black iron oxide (Fe_3O_4, Magnetite). The coating gives a bluish type of finish which is quite dur-

able, but the process is somewhat difficult to carry out and is not much used.

A black oxide finish somewhat similar to the above can be produced by immersing the metal in a tank containing fused sodium nitrate, maintained at about 300°C. A number of variations of this type of process exist. The coatings produced give a dark blue or black finish and have a certain amount of protective value, although for the most part they are not suitable for severe corrosive conditions. However, they resist wear fairly well and the corrosion resistance can often be considerably improved by impregnating with oil.

Decorative Finishes on Metals by Chemical Means

A number of decorative finishes can be produced on most of the commoner metals by dipping them into solutions which form thin films of metal salt on the surface. One of the most common processes is the production of antique bronzes, etc., on brass and copper by dipping into solutions of alkali sulphides. These processes produce films of sulphide on the metal surface and according to the thickness of the film produced the colour can be varied. In many cases the film is "relieved", that is to say a certain amount of it is rubbed away from the high spots of the article either by means of pumice powder and a brush, or rag, or in some cases a polishing mop, allowing the basic colour of the metal to show through. A similar sulphide finish is also produced on silver and is generally known in the trade as "oxy-silver", although in point of fact the film is a sulphide and not an oxide. These processes are used for finishing such articles as electric-light fittings, etc., and are principally employed for articles to be exposed to mild corrosive conditions only. In some cases the film itself has little protective value, the colour and appearance of the article being preserved by lacquering.

While it is not difficult to produce such films on the average metal surface, the matching of colours requires a good deal of experience and skill. The names of the various colour finishes also are apt to vary in different places so that if a finish is required to match an existing sample it is necessary to obtain the actual sample to match. A B.S.I. specification, however, is in existence which specifies the colour and type of finish so that a reasonable match can be obtained by its use.

Hot-dip Coatings

The Intermediate candidate is required to have also a general knowledge of the methods employed for producing coatings by hot dipping.

These processes consist in the first place of cleaning and pickling the metal article and then after fluxing, dipping it into a bath of molten metal. The most usual process in this type are galvanizing, in which the article is dipped into a bath of molten zinc, and hot tinning. In galvanizing, as previously mentioned, it is first necessary to clean the surface of the article and to remove all oxide and scale. The article is then coated with a suitable flux, generally a zinc chloride, and dipped into a bath of molten zinc. The temperature of this bath needs to be controlled fairly carefully and it is usual to keep the metal surface covered with a film of palm oil or other suitable material to prevent oxidation. After withdrawing the article from the bath it can, if necessary, be either brushed or centrifuged to remove surplus metal. In some cases alloying materials are added to improve the performance of the coating.

The hot-tinning process is carried out in a similar manner. The majority of tin-plate used for making tins is produced by this method. In tinning cast-iron articles, for example mincers and the like, it is usual to coat the article first with a thin coating of electrolytic iron by means of a normal plating process, as this coating takes up the tin film better than the cast iron and gives a more satisfactory finish.

Plating Calculations

A candidate for the Intermediate examination is required to have some knowledge of the methods employed for working out the amounts of current, time, etc., for producing deposits of standard thickness and of the methods used to work out the amounts of chemicals required for making up known volumes of solutions of given composition, of tank capacities, and of costs of heating current, etc.

It is usual to find in the Intermediate examination paper a question on this subject for example, a candidate may be asked to work out the cost of the current required to deposit, say, 0.001 in. of nickel on a steel cylinder 6 ft. long and 1 ft. in diameter. In such a question he will normally find given various data required, though in some cases some of the required information for example, the voltage to be used may be left to him to supply.

In answering a question of this type it must be remembered that the candidate will be marked on the way he goes about his calculation, rather than the quantitative answer that he obtains. The answer, however, must be a reasonable one and if, through some error in calculation, he returns an answer which is absurd he is unlikely to obtain any credit for it.

It should also be remembered in answering this type of question that the figures used should be set out in such a way that the examiner can follow the various steps in the reasoning. Merely to give the correct figure for an answer without showing how it has been arrived at is not satisfactory. Each stage in the calculation, therefore, should be clearly shown. For example, in dealing with the cost mentioned above, it is first necessary to calculate the area of the outer surface of the cylinder concerned and then the volume of the metal required. The area of the cylinder will be its length (6 ft.) multiplied by its circumference ($\pi \times D$). Since the volume of the nickel will be the area times the thickness (0.001 of an inch) the total volume in cubic inches will be $\pi \times 12 \times 72 \times 0.001 = 2.7$ cu. in.

In the question the number of amp.-hours required to deposit a lb. of nickel (414.8) and the weight of a cubic inch (5.08 oz.) will normally be given, or at any rate some factors from which these can be calculated. The weight of the metal required will, therefore, be the number of cubic inches times the factor, 5.08×2.7 oz. and the number of amp.-hours required will be the number of lb. of nickel multiplied by the number of amp.-hours to deposit a lb., *viz.*, 414.8. From this the total number of amp.-hours required are found, *viz.*, $\frac{414.8 \times 13.7}{16} = 355$ amp.-hours and it now becomes necessary for the candidate to decide at what current density he considers the process can be satisfactorily carried out. In a case of this type it will be possible to use any current density from about 10 to 40 amp. per sq. ft. depending on rotation, etc. In answering a question of this type the candidate should state the current density which he thinks is most satisfactory for the purpose, and if possible give some reason for his choice; for example, he may say that he proposes to work the process at 20 amp. per sq. ft. calculated on the total area, rotating the cylinder in a horizontal plane about one-third immersed in the plating solution. Such processes would give quite a satisfactory result, if properly carried out. If he then proposes to work in this way using the current density of 20 amp. per sq. ft., he will require $20 \times 19 = 380$ amp. and $\frac{378}{380} =$ 55 minutes to obtain the required thickness.

Knowing the number of amp.-hours required, it is now necessary to calculate the number of watts which will have to be used to obtain this figure. For this purpose it will be necessary to know the tank voltage and the convertor efficiency. These may be stated in the question but it is quite possible that the candidate may be required to supply these from his own knowledge. Normally for a process in this type the tank voltage would be of the order of four and the convertor efficiency probably 75 to 80 per cent. The candidate should state clearly the figure that he proposes to use pointing out that from his experience this is a likely figure for the type of plant that he has in mind. The amp.-hours multiplied by the tank voltage give the watt-hours required on the tank. If the convertor efficiency is 80 per cent it is then necessary to multiply by $\frac{100}{80}$ to obtain the power requirements from the main. Assuming that the cost of the current is 1d. per unit, that is a kilowatt for one hour, the cost of the current for the above operation will be $378 \times 4 \times \frac{100}{80}$ watt-hours = 1,760 watt-hours = 1.76 kW.-hr. = 2d. (approx.).

In an examination this question should be set out as follows:—

Cylinder size: 6 ft. $\times$ 1 ft. dia.

Cylinder area: $6 \times 12 \times \pi \times 12 = 2{,}700$ sq. in.

Volume of deposit: $2{,}700 \times 0.001 = 2.7$ cu. in.

Weight of metal required: $2.7 \times 5.08 = 13.7$ oz.

Amp.-hr. to deposit: $\frac{414.8}{16} \times 13.7 = 355$ amp.-hr.

At 20 amp. per sq. ft.

$$\text{current} = \frac{2{,}700}{144} \times 20 = 378 \text{ amp.}$$

Time required: $\frac{355}{378}$ hr. = 0.94 hr. = 55 min. (approx.)

Watt-hr. at 4 volts = $355 \times 4 = 1{,}420$ Watt-hr.

Watt-hr. from main (assuming 80 per cent efficiency) =

$$\frac{1{,}420 \times 100}{80} = 1{,}775 \text{ watt-hr.}$$

$$= 1.775 \text{ KVA}$$

Cost (at 1d. per unit) = 1.775d.

i.e. Approx. 2d.

It will be seen that in a question of this type different candidates may assume different values for those factors which are not given, as previously pointed out; however, a candidate is marked on the method of calculation that he employs and provided the factors that he assumes are reasonable, he will obtain full marks for the question if his working out is correct. A candidate who assumes unreasonable figures will undoubtedly lose marks and therefore he should be aware of the normal voltages required on operations of this type and of the overall efficiency of a normal motor generator and plating rectifier.

Having worked out the required figure, he should consider whether it is a reasonable one, particularly as in the examination it is not diffi-

(*Continued in page 34*)

A Students Guide to Examination Courses

(*Continued from page 33*)

cult to place a fraction upside down or to misplace a decimal point. If the figures appear to be unreasonable, the workings should be carefully checked. In the main, these questions on calculation are comparatively quick and easy to answer and a candidate may be assured of obtaining a high proportion of marks on a question of this type if he pays a little attention to the points mentioned.

Not only are these questions easy from an examination point of view, but it is quite essential in practice for a man in charge of a plating shop to be able to make simple calculations of this type quickly and correctly; it is quite obvious that if mistakes are made in such calculations on the floor of the plating shop very considerable troubles may be involved resulting in considerable loss of time and often material and money to the business concerned. For example, if an operator, who is required to add 1 oz. per gallon of a certain critical chemical to a solution, calculates the volume of the solution in the tank or the amount to be added wrongly and puts in perhaps ten times more material than instructed, then the whole process is put out of commission, involving either the scrapping of the solution or a considerable amount of trouble in removing the excess material. It is very essential, therefore, that those people who are to take charge of plating operations should be thoroughly familiar with the correct methods of making calculations of this type and even when actually undertaking this work should make a practice of setting out their calculations clearly so that others can easily check them through. Too great an emphasis cannot be put on this matter.

(*Series to be continued*)

Stoving by Convection and Radiation

(*Continued from page 29*)

perature is and if it can be exceeded without causing damage to the article;

(7) the space available."

The above technical considerations will, however, have to be supplemented by financial considerations as mentioned earlier in this survey.

Summing up, it can be safely stated that during the last few years there has been a steady growth of gas-fired radiant heating plants. Some hundreds of gas-heated infra-red tunnels and several thousands of emitter panels are now in regular industrial use. Lately it seems that interest in tunnels has again become greater in cases where uniform size and shape of goods is prevalent.

(*To be continued.*)

Bibliography

Hayman, R. F. "Development in the Industrial Uses of Gas." Paper presented, 1954, to the National Smoke Abatement Soc., London, S.W.1, publ. by The Gas Council, London.

Hill, H. R. "Radiant Heat Processing in Industry." *Machinery Lloyd*, London, 1952, June 21.

Tyrrell, A. E. "Gas-heated Plant for Stoving by Radiant Heat (Infra-red)." *Electroplating and Metal Finishing*, London, 1955, Feb.

"Gas in Industry." Publ. by The Gas Council, London, S.W.1.

Lockwood, F. W., and Davies, D. J. "Town Gas High Temperature Radiant Heating in Industry." Paper read to *London and Southern Junior Gas Assoc.* 1952, Nov. 21st.

Walter, Leo. "Infra-red Drying and Baking." *Canadian Paint and Varnish Magazine*, Toronto. 1953, Oct.

Howell, W. F. "The Efficient Use of Gas in Industry." *Fuel Economy*, London, 1953, Dec.

Ernst, R. C. and Schumacher, E. F. "Infra-red Radiant Heat Baking of Enamels." *Ind. and Eng. Chem.* 1944.

Nelson, J. H., and Silman, H. "The Application of Radiant Heat to Metal Finishing." Publ.: Chapman and Hall, Ltd., London, 1945.

"Notes on Drying Paints by Radiant Heat (Infra-red)." Publ.: Imperial Chemical Industries Ltd., Slough, Bucks.

(Literature supplied by makers of radiant gas-heated stoves.)

Overseas Review

(*Continued from page 30*)

steel, Monel, pure nickel, etc. It is not recommended for applications where the corrosion rate of nickel exceeds 0.0016 in. per year.

Oddments

Those watching the progress of ultrasonics in metal finishing should be interested in some laboratory experiments by Rich(7) who found a tendency for high-frequency ultrasonics to reduce certain undesirable effects during electroplating. Low-frequency vibration at 20 kilocycles per second eliminated anode polarization, permitted faster plating, minimized edge build up and produced more uniform, tightly bonded coatings in a cadmium cyanide solution. Similar benefits were also obtained in limited tests using silver, chromium and copper plating solutions.

One of the Douglas factories employs seven different treatment systems for applying protective coatings to aluminium airframe components. These include Iridite 14, Alodine 1200, chromic-acid, sulphuric-acid, and hard-anodizing (Sanford process). They are therefore in an excellent position to compare these processes(8). In describing their experience it is stressed that there is no " best " process, each has its own particular field depending upon the alloy, application, and type of component.

References

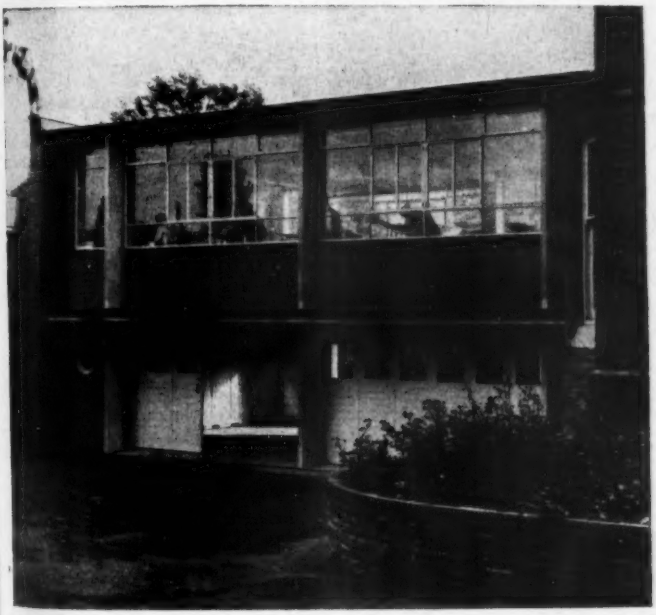
(1) *Iron Age*, 1955, 175, (17), p. 103.
(2) *Plating*, 1955, 42, (10), pp. 1266-1267.
(3) *ibid.* pp. 1251-1254.
(4) *Products Finishing*, 1955, 19, (12), pp. 76, 78.
(5) *Mat. and Methods*, 1955, 42, (3), pp. 96-98.
(6) *ibid.* 1955, 42, (5), pp. 112-114.
(7) *Plating*, 1955, 42, (11), pp. 1407-1411.
(8) *Light Metal Age*, 1955, 13, (10/11), pp. 20-23, 35.

FINISHING

NEWS REVIEW

METAL-FINISHING ENGINEERS COMPLETE FURTHER EXTENSION OF PREMISES AND FACILITIES

New Drawing Office for Stordy Engineering Ltd



In April, 1951, the Stordy Engineering Ltd., moved from their original premises in Princess Street to their present larger offices at Cumbria House, Goldthorn Hill, Wolverhampton. They have since built an extra drawing office and garage accommodation. The drawing offices now cover a floor area of 800 sq. ft.

The firm manufactures furnaces, industrial ovens, metal-finishing plant and drying plant and has built up a large technical-design and drawing-office staff and are gradually extending the works side of the organization to cover more fully the manufacturing side of the business. Complete galvanizing plant, engineered as production lines, including pickling, washing, fluxing, drying and hot-dip galvanizing with all the ancillary mechanical-handling equipment are also manufactured.

Stordy industrial furnaces incorporating air circulation are designed and built for heating by electricity, oil or gas at temperatures up to and including 700° C. for annealing (including flash-annealing) and for general heat treatment within this temperature range.

The Stordy industrial ovens, have an air circulation system designed to give rapid heating and precise temperatures over the entire working area. Designed as either static or fully mechanized plant with all handling gear and heated by steam, high-pressure hot water, oil, gas or electricity, the various types cover the whole field of industrial oven application.

The company builds equipment for the application of paints, enamels and metal finishes, complete schemes being engineered for fully automatic and batch installations, including pre-treatment processes, de-greasing, pickling, phosphate coating and intermediate rinsing and drying off; paint dipping, draining, drying and stoving. Fully-mechanized continuous plant incorporates all mechanical-handling gear and ancillary apparatus—loading tables, gravity-rolling conveyors and overhead conveyors, paint storage, etc.

A HAPPY AND PROSPEROUS NEW YEAR

The Editors, the Area Managers, and the Staff of METAL FINISHING JOURNAL extend to all readers, advertisers, contributors and other friends in the industry at home and overseas, sincere and cordial good wishes for their happiness and greater prosperity in the year that lies ahead.

OBITUARY

Cossey: Borax Consolidated Ltd., announce the sudden death on December 14, 1955, as the result of a heart attack, of the head of their technical sales department, Mr. James Cossey, M.Sc., A.R.C.S., A.R.I.C., D.I.C.

Born in Ormsby St. Michael in 1913, he took his degree in chemistry from the Royal College of Science 1932/35 and obtained the D.I.C. in agricultural chemistry. He served in the R.A.F. during the war and resumed his engagement with Borax Consolidated, Limited, in 1946. In recent years he has visited various overseas markets and had acquired a very specialised knowledge of the borax industry.

Apart from the sad bereavement suffered by his widow and relatives, his loss will be greatly felt by his colleagues and his many friends and trade connections.

Change of Name

IT has been announced by Adhesive Dusters that they have now become a limited company. They will be known in future as **A. D. Tack Rags and Adhesive Dusters Ltd.** There has been no change in the address which remains at: St. John's Street, Kates Hill, Dudley, Worcs.

Post-Graduate Lectures at Kingston

A COURSE of six post-graduate lectures on "Recent Developments in the Study of Corrosion" will be given at Kingston Technical College, Kingston Hall Road, Kingston-on-Thames, on Monday evenings beginning on January 23, 1956, by members of staff of the Corrosion of Metals Group of the Chemical Research Laboratory. Dr. W. H. J. Vernon, O.B.E., will give the inaugural lecture. The course has been organized for scientists and engineers in industry, research and teaching, and others interested in recent developments in this field. The fee for the course will be 10*s*.

New London Office

To deal with enquiries and sales in London and South-East England, **Air Control Installations Ltd.**, have opened a new branch office in central London.

The address of this new office is 17 Manchester Street, London, W.C.1.; telephone number WELbeck 1306 (2 lines).

21 Years of Finishing

The Ealing & District Plating Co. Ltd., of Seaford Works, Seaford Road, West Ealing, London W.13, is now celebrating 21 years of business as a metal finishing works.

Metal finishing processes now being undertaken here include plating with chromium, nickel, cadmium, silver, and gold, together with the anodising and dyeing of aluminium.

About half of the work undertaken is concerned with the protective treatment of engineering and scientific instrument components. Most of the rest of the work consists of decorative chrome domestic articles and the gilding of jewellery.

PAINTS AT THE BOAT SHOW

Protection from Heat and Corrosion

THE accent was on finish at the Second National Boat Show sponsored by the Daily Express and organized by the Ship and Boat Builders' National Federation.

Held at the Empire Hall, Olympia, London, from December 29, 1955 to January 10, 1956, it was an impressive spectacle.

Among the many exhibitors were Llewellyn Ryland Ltd., Balsall Heath, Birmingham 12, who had on show their Silvoline aluminium paint for use on iron work, rails and davits which has a smooth, metallic finish; engine enamel which is claimed to be heat resisting and is specially prepared to resist oil, petrol and heat; No. 999 aluminium paint which is also heat resisting. In addition they were exhibiting their range of polyester colour pastes. The medium used in these is a pure resin of the polyester type which is capable of chemically cross linking with the parent polyester so that no leaching out with solvents or migration occurs.

Cellon Ltd., Kingston-on-Thames, were showing their range of marine finishes. These included primers, undercoat and finish for use on steel or light alloy craft both above and below the water line. These Cerrux paints incorporate alkyd resins and are claimed to be resistant to corrosion by sea and salt.

Polished, chrome and polychromatic colour finishes, featuring single colours, dual tones and combinations of chrome and colour portlights were shown by Dover Industries Ltd.

IDEAL HOME EXHIBITION 1956

FOR nearly fifty years the *Daily Mail* Ideal Home Exhibition has displayed the latest developments in home design and equipment.

The next Exhibition, to be held at Olympia from March 6 to 31, 1956, will have as its special attraction a "House of the Future," which will incorporate all the latest ideas in architecture, building, equipment and social planning.

The organizers are already assured of a larger attendance of foreign buyers than ever before, although only a few continental countries either plan or equip their homes with anything like the modernity of ideas or equipment which are now so general in this country.

SPRAYING FOR SAFETY

Preparation given to "Sno-Cat" before leaving for Antarctic

AS a goodwill gesture towards the Trans-Antarctic Expedition, Export Packing Service. Ltd. has volunteered to undertake the preservation and packing of the four giant "Sno-Cats" purchased by the Expedition for the transportation of men and materials over a distance of two thousand miles.

Made by the Tucker Sno-Cat Corporation, of Medford, Oregon, U.S.A., these heavy vehicles with tracked pontoons instead of wheels, weigh 3½ tons each, and measure 20 ft. × 8 ft. × 8 ft. They will be travelling as deck cargo, passing through the tropics, and will thus be exposed to practically every climatic and atmospheric condition it is possible to encounter, down to —40° F. in the high summer of Antarctica, where parts of the territory are sometimes subjected to winds of up to 200 m.p.h.

The first "Sno-Cat" left London Docks last month the remaining three will follow in twelve months time.

The "Sno-Cat" arrived by road at the Sittingbourne depot of Export Packing Service after several delays and postponments. Careful pre-planning, both of design and labour requirements, meant that work began immediately. The progress was planned in the following stages:—

The base of the packing case to hold the "Sno-Cat" was built, and sprayed with plastic and the vehicle itself, weighing 3½ tons, was handled into position on this specially prepared base. Then the whole vehicle was covered with muslin scrim, and secured to the base with adhesive. Cellulose wadding kept the muslin clear of the "Sno-Cat" itself on the corners and sharp projections, and the Perspex windows of the vehicle were masked off with protective materials. It was then sprayed with Trotoplast No. 1. The final thickness of the sprayed plastic coating was approximately 0.035 in., and as each spraying operation deposited a thickness of from 0.01 to 0.012 in. three such applications were necessary. The final one of which was of aluminium pigmented plastic which will help to reflect light and heat away from the "Sno-Cat" during the voyage.

After spraying, the bag was slit in two places, and a cold air hose applied through one aperture to disperse the solvent vapour inside. Bags of desiccant in the form of silica-gel were inserted, and the slits sealed and sprayed over.

It is hoped to achieve a 30 per cent or less humidity inside the plastic spray coating.

CHANGES OF ADDRESS

The Design and Research Centre for the Gold, Silver and Jewellery Industries, has changed its address to Saint Dunstan's House, Carey Lane, London, E.C.2. Telephone Nos.: MONarch 3180, MONarch 0871 (research section).

* * *

The "Mastral Division" of the **Kingsland Engineering Co. Ltd.,** has been transferred to their parent company, the address of which is: Howard Wall Ltd., 25/37, Hackney Road, London, E.2.

CHANGE OF TELEPHONE NUMBER

It has been announced by the head office of the **Cambridge Instrument Co. Ltd.,** 13, Grosvenor Place, London, S.W.1., that their telephone number has been changed to BELgravia 5066 (8 lines).

COMMITTEE TO REVIEW HALL-MARKING LAWS

THE President of the Board of Trade, Mr. Peter Thorneycroft, announced in the House of Commons on December 9 that he had appointed a Departmental Committee on hall-marking under the chairmanship of Sir Leonard Stone, O.B.E. The other members of the Committee are Lady Sempill; The Hon. W. D. Watson, W.S.; Dr. J. H. Watson, M.B.E., M.C.; Mr. J. F. Brown and Mr. R. H. King.

Its terms of reference are: "to examine the state of the law on the assaying and hall-marking of precious metals including the passing off of basemetals as precious metals and to recommend what revision of the law is desirable in the light of present-day conditions."

Organizations and persons who wish to give evidence should write to the Secretary, Miss B. Hirst, Board of Trade, Horse Guards Avenue, London, S.W.1., before January 31, 1956, giving some indication of the matters they wish to discuss.

Meetings of the Month

January 16

Institute of Metal Finishing (London Branch). "The Effects of Metal Finishing Wastes on Sewage Purification," by A. E. J. Pettet, B.A., M.Inst.S.P. (Joint meeting with the Institute of Sewage Purification) at Imperial College, South Kensington, London, S.W.7. 6.15 p.m.

January 19

Institute of Metal Finishing (Midland Branch). Annual Dinner and Dance, at the Grand Hotel, Colmore Row, Birmingham, 3.

February 7

Institute of Metal Finishing (Midland Branch). "New Developments in Metal Finishing Sequestering Agents for Plating" by F. Wild, A.I.M., "Epoxy Resins," by M. J. Wilson, "Silicone Finishes" by P. A. J. Gate. (Joint Meeting with Organic Finishing Group) at the James Watt Memorial Institute, Great Charles Street, Birmingham, 3. 6.30 p.m.

January 24

Institution of Chemical Engineers. (Joint meeting with the Corrosion and Chemical Engineering Groups, Society of Chemical Industry) "Control of Corrosion in the Heavy Chemical Industry" by D. R. Himsworth and W. D. Clark, at the large Lecture Theatre, Kings College, London, W.C.2. 6.30 p.m.

January 26

Institute of Vitreous Enamellers (Midland Section). "Glass to Metal Seals" by Dr. J. H. Partridge. (Joint meeting with the Society of Glass Technology—Midland Section) at the Birmingham Exchange and Engineering Centre.

January 27

Institute of Metal Finishing (Sheffield and N. E. Branch). "Barrel Polishing and Burnishing," a technicolour sound film, at the Grand Hotel (Fitzwilliam Room), Sheffield. 6.30 p.m.

February 1

Institute of Metal Finishing (Scottish Branch). "The Mechanical Properties of Electrodeposits Used in Engineering, with Particular Reference to Fatigue Strength," address by the president, R. A. F. Hammond, B.Sc., A.R.C.S., F.R.I.C., at the Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow. 7.30 p.m.

TRADE and TECHNICAL PUBLICATIONS

Tin Coating: In the October edition of "Tin and its Uses," the quarterly journal of the Tin Research Institute, Fraser Road, Greenford, Middlesex, are four articles on tin coating. One is on a simple coulometer method for tin coating determination and describes a new apparatus for the measurement of tin-coating thickness which dispenses with the need for a costly high-speed recording potentiometer.

Hot-tinning cast iron by the direct chloride method and the purity of tin foil coatings, with special reference to food cans and utensils, are also dealt with.

Finally, there is a discussion on tin-alloy coatings as alternatives to nickel chromium. As a result of large-scale exposure tests, tin-nickel appears to be as fully resistant to tarnish and corrosion as chromium.

* * *

Spray Finishing: A brochure called "Facts" which presents in pictures the products of some well known users of Devilbiss Aerograph spray equipment has just been published by the Aerograph Co. Ltd., 47 Holborn Viaduct, London, E.C.1. The company point out that sales appeal depends to a large extent on the finish of the product, and claim that they can improve the quality or maintain it at the highest level without increasing expenses.

February 2

Institute of Metal Finishing (N.W. Branch). Film, "Die Casting—How Else Would You Make It?" followed by a short paper:—"Die Casting Finishing"; Speaker and film from the Zinc Development Association, at the Engineers' Club, Albert Square, Manchester. 7.30 p.m.

Birmingham Metallurgical Society. "Modern Case-Hardening Processes," by P. F. Hancock, B.A., F.I.M., in the Lecture Hall, James Watt Memorial Institute, Great Charles Street, Birmingham, 3. 6.30 p.m.

February 7

Institution of Chemical Engineers. "Liquid Atomization and the Drop size of Sprays" by R. P. Fraser and P. Eisenklam, at the Geological Society, Burlington House, London, W.1. 5.30 p.m.

February 8

Institute of Vitreous Enamellers (Southern Section) Symposium on "Automation in Vitreous Enamelling" including contributions on:—
"Mechanization of Pickling" by J. Stack. "Mechanization of Spraying" by W. B. Noon. "Mechanization of Handling and Fusing" by T. M. Lees. at the Howard Hotel, Norfolk Street, Strand, London, W.C.2. 7.15 p.m.

Technical Chemicals for the Paint Trade: A new book giving details of products of particular interest to the paint trade has been published by Howards of Ilford Ltd., Ilford, Essex.

This book, of 138 pages, is full of information on chemicals at present in use in the paint trade.

In three main sections, each dealing with separate aspects, followed by tables, appendix, product index and subject index, it makes a most comprehensive guide.

The first section deals with solvents, plasticizers and resins in the cellulose-lacquer industry. It describes solvents, their power and balance, diluents, boiling ranges, vapour pressure and evaporation rates, plasticizers, synthetic and natural resins and rosin esters. In this section, there is a sub-section on Howard's technical chemicals in the cellulose-lacquer industry and some typical formulations.

The second section is devoted to oil paints, varnishes, and synthetic finishes, including film-formers and Howards solvents, plasticizers and polyhydric alcohols with a sub-section on the various classes of paints and paint products.

Physical properties and applications of Howards solvents, plasticizers and technical chemicals are dealt with in this third section.

Some of the chemicals dealt with at great length are diacetone alcohol, sextone, plassitil, resin MS2, sorbitol and glycerol lactate.

In the appendix are viscosity conversion tables, plasticizer compatibilities, graphs on vapour pressures and a colour conversion chart.

* * *

"Jenolite News": Vol. 7, No. 11 of this publication from Jenolite Ltd., 13-17, Rathbone Street, London, W.1. deals with the use of the company's products in cathodic protection. It explains what electrochemical corrosion is, the differences of electrochemical potential set up at interfaces between steelwork and water which has penetrated through its protective coating and how the metal passes into solution as positive ions. The qualities of the company product in particular, the high electrical resistance of the phosphate coating, it is claimed, reduces the areas susceptible to attack.

Also included in the issue is an article on the first Italian ship to be pre-treated with Jenolite RRN against corrosion.

* * *

Buffing and Polishing Compounds: Characteristics and uses of over 100 buffing and polishing compounds are

(*Continued in page* 39)

TRADE & TECHNICAL PUBLICATIONS

(*Continued from page* 38)

described and illustrated in a new bulletin published by the Hanson-Van Winkle-Munning Co., Matawan, N.J.

Listing the company's complete line of compounds, the 24-page two-colour bulletin contains a full-page chart which recommends cutting, colouring and double-duty compounds to be used with twelve different metals, plastics and hard rubber.

Specific compounds are classified and described, with recommended usage, under the general headings of tripoli, cut and colour compounds, steel and stainless-steel buffing compounds, emery paste and cake, crocus, polishing lubricants, rouges, greaseless compounds and special buffing and polishing compounds.

Thirty-five photographs illustrate various compounds and a full-page diagram shows a typical installation of the company's automatic liquimatic buffing equipment.

* * *

"The Metavin System": This is the title of a pamphlet produced by Croda Ltd., Organic Finishes Division, Croda House, Snaith, Goole, Yorks. It contains a general description of the Metavin system as well as its uses and method of application.

The difference between this system of paints and other paints is that they are based on relatively inert plastics rather than natural oils or resins.

As the plastics are water-white in colour it is claimed that it is possible to make paints of any colour from them, including pure white.

* * *

Cutting Fuel Costs: Last year, for the first time in our history, we imported more coal than we exported—at a cost of £80,000,000 in foreign exchange. If all coal users could make only a ten per cent reduction in their consumption, at least 2,000,000 tons would be saved in a twelvemonth. This would be £14,000,000 in our balance of payments.

In a pamphlet entitled "Fuel Conservation and Productivity," price 9d. the British Productivity Council 21, Tothill Street, London, S.W.1., sets out the main points which managements need to look at if they are to make sure that their fuel costs are cut to the minimum.

It is pointed out that savings can usually be made at many points besides the boiler-house. Stress is laid on the need for trained firemen and details are given of courses available for them. Many of the methods described for saving can be installed with very small capital expenditure. The pamphlet also gives notes on the advisory services available to industry from the National Industrial Fuel Efficiency Service (N.I.F.E.S.) and from the Federation of British Industries; and on the Government Loan Scheme which is designed to help firms to finance the installation of equipment to secure more economical use of fuel.

* * *

B.C.A.S. Handbook of Pneumatic Equipment: This handbook, which comprises some 210 pages, explains the characteristics, features and uses of a wide variety of compressed-air equipment such as air and gas compressors, paint spraying equipment, pneumatic tools, etc. Written in an easily understandable style, it will be useful to buyers and purchasing agents as well as for use in training and reference purposes.

The present edition incorporates a completely revised sixteen-page buyer's guide, containing a full list of names and addresses of members and associate members, and a classified list of products from which the manufacturers of over 250 separate items of compressed air equipment can be easily ascertained.

This new edition, price £1 post free by surface mail, can be obtained from the British Compressed Air Society, 32 Victoria Street, London, S.W.1.

"The Bonderizer": The January issue of this booklet published by the Metal Finishing Division of the Pyrene Co. Ltd., Great West Road, Brentford, Middlesex, contains a full account of the new all-steel carriages being manufactured by British Railways.

These coaches are fabricated by a virtually all-welding technique and have to withstand particularly severe exposure from corrosive atmospheric agents. Pre-treatment plants have been set up at various British Railways depots to deal with this and they have been using either the "Bonderizing" or "Parkerizing" techniques.

Also included in this issue is the use of "Bonderize" pre-treatment in the manufacture of electric and convector heaters to ensure good protection from corrosion and a bond for paint.

TECHNICAL AND INDUSTRIAL APPOINTMENTS

Mr. F. B. Howard-White, who was appointed a director of Henry Wiggin and Co. Ltd., in May of last year, has now been appointed a member of the **Mond Delegate Board.**

Mr. Howard-White was educated at St. Pauls School and took honours in the Mechanical Sciences Tripos at Cambridge. For several years he has been a member of the Colonial Office Advisory Committee on Colonial Geology and Mineral Resources and in recent years has travelled abroad on important missions for the parent company.

* * *

Mr. E. Heymann has retired from **Silvercrown Ltd.,** after sixteen years as the company's managing director.

The new management will be headed by his colleagues of many years standing, *viz.*, Mr. G. Schmerling (general manager) and Mr. C. K. Scarfe (assistant general manager).

* * *

Mr. E. A. Ollard is relinquishing his appointment as electrodeposition adviser with **The British Non-Ferrous Metals Research Association** to join the board of **Atlas Plating Works Ltd.** Mr. S. W. Baier is joining the staff of the Research Association to undertake the liaison work with the metal-finishing industry.

* * *

After an association of over 50 years with **W. Canning and Co. Ltd.,** Mr. George A. Pope, the deputy chairman and joint managing director has retired.

He entered the business as an "improver" in 1898, at the age of 17, his starting wage being 12s. per week. and made rapid progress. After serving through the works and drawing office, he became works manager and then general manager of the engineering works.

In 1920 when the business became a public liability company Mr. Pope became one of the first directors. He was appointed joint managing director in 1937 and became deputy chairman of the company in 1953.

* * *

Mr. D. H. Cutler, M.A., and Mr. W. S. Wood, B.Sc., F.R.I.C., A.M.I.Chem.E., have been appointed directors of **Laporte Chemicals Ltd.**

Mr. J. T. Richmond has been appointed a director of **Laporte Titanium Ltd.**

* * *

Mr. A. P. Lowes, production manager of **Whiffen and Sons Ltd.** (Industrial and Pharmaceutical Chemical Division of Fisons Ltd.) has been appointed a director of the company.

* * *

Mr. H. L. Evans has been elected chairman of the **Lead Development Association.** He succeeds Mr. H. A. Sewell, who relinquished the appointment after serving for two years.

Latest Developments in PLANT, PROCESSES and EQUIPMENT

Hydrovane Rotary Compressor

THIS compressor has been available for 3 years and during this time continuous development work has been going on. Now a modified form (laminar type) of cooler is being fitted as standard. This is claimed by the manufacturers to reduce the operating temperature of the compressor and further increase its efficiency. (Fig. 1)

The cooler was first produced to meet conditions in the tropics, but its success in very hot climates led to further research, and the benefits of this improvement are now available on all future compressors.

In order to be more competitive in foreign markets, the manufacturers also fit the British Standard Motor on this unit. The 40SR.1801 Hydrovane Compressor is manufactured by Alfred Bullows and Son Ltd., Long Street, Walsall, Staffs.

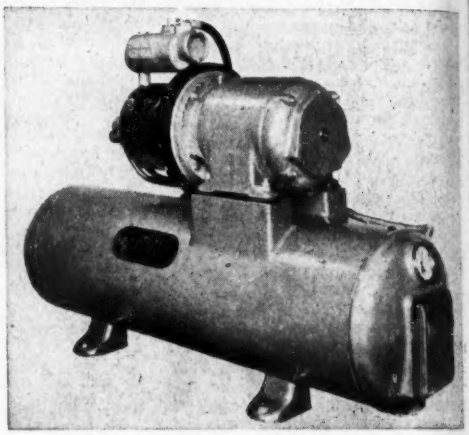


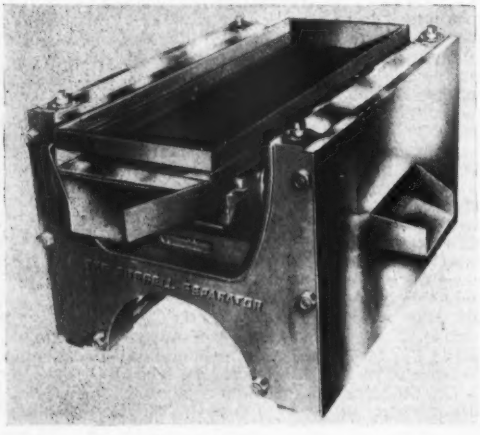
Fig. 1.—Compressor with laminar-type cooler.

Gyratory Separator

AMONG the equipment available for passing heavy slurries and viscous materials through fine meshes, the Russell separator has made itself well-known. This is a comparatively small unit with an output ranging from 1,000 to 15,000 gal. per hr. according to the type of material being processed. It frequently transpires that outputs greater than these are called for, but it would appear that the Russell gyratory system only operates at its maximum efficiency in one particular critical size of unit, so that in order to achieve larger outputs it is necessary to install a number of units.

In order to make possible an increased output from a single machine, Russell Constructions Ltd., 8, Adam Street, London, W.C.2., are now offering a new and improved version of their separator, known as the Streamline model. This has almost doubled the output capacity of the standard equipment.

Fig. 2.—Improved gyratory separator.



Except that it is very slightly wider the new machine (Fig. 2) has the same overall dimensions as the standard separator, but by re-arrangement of the porting the operative screen area has been increased by some 23 per cent. while maintaining the full gyratory force. The unit is mounted in a heavy box-section frame which prevents the transmission of the gyratory motion to other part of the machine and eliminates the need for special foundation arrangements. The exterior of the unit is panelled in polished aluminium.

The new machine can also be equipped with mechanical brushing gear where large amounts of heavy reject material have to be dealt with, the drive to the mechanism being completely enclosed. Easy maintenance has been assured by grouping all greasing nipples on one small tablet conveniently located in the centre of the side panel of the machine.

Rust-proofing Solution

A NEW rust-proofing solution which, it is claimed, protects metal surfaces irrespective of surface roughness, and is invisible in the economic thickness required for full protection, is being manufactured by British Universal E.M.E. Ltd., 36 Victoria Street, London, S.W.1.

This new solution, Antox, consists of a special grade of plasticized nitro-cellulose dissolved in a mixture of three solvents—all of which evaporate at a different rate. It can be sprayed, dipped or brushed on, and it is claimed, it does not crack and will with-

A Step Forward

For bright nickel problems - Efco have the solution.

This new process is a logical development of the Efco-Udylite bright nickel plating process No. 31.

The new process - known as No. 514 - is characterised by an exceptionally wide bright plating range.

In addition, greatly improved line filling or levelling is obtained.

Efco-Udylite BRIGHT NICKEL PLATING PROCESS No.514

This new process has been proved by long and exhaustive test to give high lustre to steel or brass at low cost.

The uniformly bright deposits and high line filling properties result in a perfect finish, these qualities being particularly noticeable for relatively thin deposits and when plating steel components

Extremely Wide Bright Plating Range-Improved Line Filling

And Process 514·H is now available for Plating Diecastings.

Full technical data and operating instructions are available from Efco Conversions from existing Efco-Udylite processes carried out without difficulty

EFCO **ELECTRO-CHEMICAL ENGINEERING CO. LTD.**
NETHERBY, QUEENS ROAD, WEYBRIDGE, SURREY Weybridge 3891
Associated with Efco Ltd., Electric Furnace Co. Ltd. Electric Resistance Furnace Co Ltd

Rainbow

stand fog, warm or cold damp air, sea spray, heavy showers of rain or covering with snow.

Further, it is claimed, it is effective for the protection of brass, copper, nickel or chromium plating, polished iron and steel castings, forgings, aluminium and metallic alloys of all kinds.

Hard Gloss Enamel

A NEW special high-class enamel has been developed by Allweather Paints Ltd., 36, Gt. Queen Street, London, W.C.2.

It is claimed that it maintains the properties normally associated with modern alkyd-based paints.

Pitan hard-gloss enamel is an air-drying decorative enamel which will find its principal use in the decoration and protection of factories, schools, houses, etc.

Deburring Chips

IT is well known that after a certain period of use some tumbling and barrelling media including certain grades of alumina, become "pebble-like" and smooth with a consequent loss in cutting power and increase in processing time, etc. Randaleen Ltd., Chambers Lane, Sheffield 4, claim that their Rap-i-cut, deburring chips, a synthetic alumina designed solely for barrel finishing, confer several advantages when used both for the above process and for tumbling.

The main feature of the material is that a method has been developed in which by control of the "crystal growth" and arrangement of the chip structure, as the chip depreciates during use new cutting faces are continually presented to the work being processed. The "crystals" are distributed in a novel plane and lattice arrangement so that the cutting power is available throughout the life of the chip.

The chips are recommended for use on cast iron, steel and stainless steel, on which a smooth, soft matt finish is produced, and on copper, brass and aluminium, where maximum metal removal is required. Generally abrasives or abrasive-loaded compounds are not required to be used with the chips. A range of standard sizes is available and special sizes can be supplied with no additional cost.

Aluminium Cleaner

A DETERGENT for the rapid cleaning of aluminium, which is stated to be mild in alkalinity and which does not etch the metal either at the air interface or in contact with other metals, is being manufactured by Enthone Inc., 442, Elm Street, New Haven, Conn., U.S.A.

It is claimed that this "Aluminium Cleaner NE-6", has the ability to disperse oils and to remove marking ink and crayon which might be present on the surface of the aluminium sheet. The cleaner, is marketed in steel or stainless-steel containers, and is used in concentrations of 6 to 8 oz. per gal. for cast and wrought alumimium prior to anodizing, chromate treatments, organic finishing, resistance welding and electroplating.

Roughness Testing

NEW-TYPE, precision-machined calibration standards have enabled more precise measurements of surface finish to be made on the PR.9151 Roughness Tester.

The manufacturers, Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, W.C.1., claim that the maximum error on the readings is only 10 per cent. The four comparative standards supplied are used for fixing the calibration points at 125, 32, 8, 2 micro-inches respectively and are individually calibrated by "Talysurf" measurement.

The Roughness Tester is a mains driven, electronic instrument, portable enough to be taken into the workshop. The measuring pick-up is small enough to be inserted into tubes with a bore of only ½ in.

Dewatering Plant

A NEW dewatering plant has been designed by Tool Treatments (Chemicals) Ltd., Colliery Road, Birmingham Road, West Bromwich, for the application of anti-rust treatments. The plant, which can be used in conjunction with the company's dewatering fluid, is claimed to be simple in operation and to give a highly efficient treatment. An advantage is that the work is required only to be subjected to a simple dipping treatment and no heating is necessary.

The plant is manufactured in ⅛ in. mild-steel sheet and liquid tightness is ensured by ¼ in. fillet welds. The standard model of the equipment, which is finished with aluminium paint, brush applied, is 36 in. high, 22 in. wide and 28 in. long.

Classified Advertisements

Prepaid rates: FIFTEEN WORDS for 7s. 6d. (minimum charge) and 6d. per word thereafter, or 24s. per inch. Box number 2s. 6d., including postage of replies.

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

BARREL POLISHING

by Polymotion Machinery for the trade on contract basis

FOX CHEMICAL ENGINEERING WORKS LTD.,
MAYBURY GARDENS, WILLESDEN HIGH ROAD,
LONDON, N.W.10

SITUATIONS VACANT

CHEMIST & TECHNICIAN—SURFACE FINISHERS—for laboratory of light engineering works in S. Midlands. Must have sound theoretical and practical knowledge of electro-plating and surface finishing techniques. Knowledge of paint formulations and applications an advantage. Give full details of qualifications and experience, age and present salary. Box No. 515, METAL FINISHING JOURNAL.

ELECTROPLATING

A leading London Company has the following vacancies:—

ASSISTANT CHIEF CHEMIST
RESEARCH CHEMIST
ANALYST
LABORATORY ASSISTANT

Five-day week, voluntary Superannuation Scheme; time off for part-time studies for the last two named vacancies. Applications, which will be treated in strictest confidence, giving full details of previous experience and qualifications, to Box No. 514, METAL FINISHING JOURNAL.

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